REPORT

OF THE

SECRETARY OF AGRICULTURE.

1891

WASHINGTON
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1892

[PUBLIC RESOLUTION—NO. 23.]

Joint resolution providing for the printing of the Agricultural Report for eighteen hundred and ninety-one.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That there be printed four hundred thousand copies of the Annual Report of the Secretary of Agriculture for the year eighteen hundred and ninety-one; seventy-five thousand copies for the use of the Senate; three hundred thousand copies for the use of the House of Representatives, and twenty-five thousand copies for the use of the Department of Agriculture; the illustrations for the same to be executed under the supervision of the Public Printer in accordance with directions of the Joint Committee on Printing, said illustrations to be subject to the approval of the Secretary of Agriculture.

SEC. 2. That the sum of two hundred thousand dollars, or so much thereof as may be necessary, is hereby appropriated, out of any money in the Treasury not otherwise appropriated, to defray the cost of printing said report.

Approved, March 3, 1891.

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REPORT

OF THE

SECRETARY OF AGRICULTURE.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., October 27, 1891.

To the PRESIDENT:

I have the honor to submit my third annual report as Secretary of Agriculture, and it is with no little gratification that I assume this duty. Two years ago the condition of agriculture was a subject of grave anxiety, an anxiety which among the farmers themselves found vent in an almost universal expression of unrest and discontent with existing conditions. Last year I was able to indicate the beginning of an improved condition of agriculture in response to the well-directed efforts of your administration, aided by the wise enactments of Congress, and to point out the several methods adopted in the Department of Agriculture with a view to ameliorating the condition of our farmers, and to record also indications of their successful outcome. To-day I lay before you a report full of encouragement. The good work so promptly undertaken has been maintained and developed. The time that has elapsed since some of the most important measures for the benefit of the farmer were adopted, short though it has been, has already served to produce many of the good results expected of them. The work of this Department on behalf of the farmer has been constant and varied, every effort being made to enlarge the sphere of its usefulness to the fullest extent compatible with the means placed at my disposal, and the responsibilities and powers imposed upon the Department by wise legislation have been exercised with due appreciation of their importance, and pushed forward with energy and activity. In carrying on this work it gratifies me to be able to acknowledge the cordial good will and intelligent activity which the responsible officers of the Department have brought to my aid.

The wide enlargement of the powers of this Department, the general recognition of the added dignity which attaches to an executive depart-

ment of the Government, and, in general, the sense of enlarged ability for the accomplishment of good, have had the natural result of serving as an incentive to further effort on the part of every member of the force. Furthermore, our efforts have been encouraged by rapidly increasing recognition of the value of the Department, and of its possibilities on behalf of practical agriculture. Evidences of such appreciation are, and have been, multiplying from all sections of the country and from all classes of our people. Not only has the efficiency of the Department been cordially recognized within the limits of our own country, but its work has elicited practical tokens of appreciation abroad, of the greatest value to our agricultural interests.

It is also a matter of congratulation that in this year of plenty we shall be able out of our abundance to supply needed nourishment to many millions of people in Europe who have not been as fortunate as ourselves in reaping a full harvest.

I have the honor to present herewith tables and other statistical data of interest in this connection. The tables showing prices of agricultural products give wholesale prices at points selected to represent every section of the country. The figures given are prices on the first trading day of the month, and the months given are selected in order that a comparison of present prices with those ruling about the same time in 1889 and 1890 may be made. The showing of advance in values of live stock at Chicago is particularly gratifying, indicating as it does a healthy reaction from the depression under which the live-stock industry labored during recent years.

Wholesale prices of agricultural products at leading cities in all sections of the United States.

CORN.

[Per bushel.]

Date.	Boston.	New York.	Atlanta.	New Orleans.	Cincinnati.	Chicago.	St. Paul.	St. Louis.	San Francisco (per cental).
1891.	*No. 2 mixed.*	*No. 2 mixed.*	*White.*	*No. 2 mixed.*	*No. 2 mixed.*	*No. 2.*	*No. 3 mixed.*	*No. 2.*	*No. 1 white.*
August	$0.76 –$0.77	$0.71¾–$0.72	$0.87	$0.72	$0.63	$0.60 –$0.60¼	$0.58 –$0.60	$0.53¼–$0.54	$2.05 –$2.11
September	.76	.74 – .75	.85	$0.74 – .75	$0.64 – .64½	.64¼– .65	.58 – .59	.58¾– .59	1.85 – 1.87½
October	.67 – .68	.61⅞– .62	.82	.69 – .70	.57	.52½– .53¼	.48 – .52	.53	....
1890.									
August	.57½– .58	.52¼– .52½	.67	.55	.49 – .50	.45¾– .46	.44 – .46	.43¾	1.17½– 1.20
September	.57½– .58	.53½– .54¼	.70	.61	.48½– .49	.45¼– .46	.47½– .49	.44 – .44½	1.32½– 1.35
October	.60	.56 – .56⅜	.68	.63	.53 – .53½	.47¾– .48½	.47 – .48	.47¾– .48	1.27½– 1.30
1889.									
August	.48¼	.44⅜– .44⅝	$0.56 – .58	.45 – .45½	.38 – .38⅜	.36½	.34 – .35	.33¼	1.35
September	.47	.42¾– .43	.56 – .58	.45	.35	.33½	.34½	.29⅞	1.12½
October	.44 – .44½	.39½– .39⅞	.54 – .56	.44 – .45	.36 – .37	.31 – .31⅛	.31½– .32	.29⅜	....

WHEAT.

[Per bushel.]

Date.	Boston.	New York.	Atlanta.	New Orleans.	Cincinnati.	Chicago.	St. Paul.	St. Louis.	San Francisco (per cental).
1891.		*No. 2 R.W.*	*Winter.*		*No. 2 R.W.*	*No. 2 R.W.*	*No. 2 North'n.*	*No. 2 R.W.*	*No. 1 white.*
August	....	$0.99 –$0.99¼	....	....	$0.87 –$0.87½	$0.87½–$0.88	$0.92 –$0.93	$0.84⅜–$0.84¾	$1.55 –$1.56¼
September	....	1.07¼– 1.08¾	....	....	.98½– .99	.98½– .99½	.88 – .91	.97½– .97¾	1.70 – 1.71¼
October	....	1.03⅛– 1.04¼	....	....	.97 – .97½	.95 – .95¼	.87 – .88	.93¾– .93⅞	....
1890.									
August	....	.97⅜– .97⅞	....	....	.93	.91 – .91¾	.88 – .90	.88	1.37½
September	....	1.04¾– 1.06	....	....	1.00	1.00¾– 1.03	....	.98½– .99⅜	1.37½– 1.38¾
October	....	1.02⅝– 1.03½	....	....	.97 – .99	.96¼– .97½	.90 – .91	.97¾– .98¼	1.32½
1889.									
August	....	.88⅜– .89⅛	....	....	.78 – .79	.78 – .78¼	.84 – .86	.74½	1.33¾
September	....	.85⅛– .86¾	$0.78⅝–$0.79⅛	....	.75 – .76	.78 – .78¼	.73 – .74	.76⅛– .76¼	1.28¾
October	....	86¼– .87	.78 – .79	....	.81 – .83	.81⅜– .82	.75	.79½	1.32½

Wholesale prices of agricultural products at leading cities in all sections of the United States—Continued.

OATS.

[Per bushel.]

Date.	Boston.	New York.	Atlanta.	New Orleans.	Cincinnati.	Chicago.	St. Paul.	St. Louis.	San Francisco (per cental).
1891.	*No. 2, white.*	*No. 2, mixed.*	*No. 2, mixed.*	*No. 2.*	*No. 2, mixed.*	*No. 2.*	*No. 2, white.*	*No. 2.*	*No. 1.*
August	$0.48 -$0.50	$0.37	$0.50	$0.45	$0.31½-$0.32½	$0.27½-$0.28	$0.37-$0.38	$0.27½-$0.28	$1.47½
September	.41	$0.35¼- .35¾	.46	.41	.31½- .32	.28½- .28¾	.27- .28	.28	$1.32½- 1.35
October	.37 - .37½	.33- .33¼	.44	.37½	.30½- .31¼	.26¾- .27	.27- .28	.27¼- .27½	
1890.									
August	.44½- .45½	.40	.48	.45	.36¾- .39	.32½- .34		.33½	1.60
September	.46 - .46½	.40¼- .40½	.50	$0.47 - .48	.38½- .39	.35 - .35½		.33	1.60 - 1.62½
October	.47½- .48½	.43¾- .44	.50	.47	.40½- .41	.38¼- .38¾		.39	1.52½- 1.55
1889.									
August	.35 - .36¼	.27⅞- .28	$0.37- .38	.32	*.26	.21¾	.27- .28	.21½	1.12½
September	.31 - .31½	.26¾	.32- .34	.28½- .29½	.21 - .21½	.19¼	.20- .22	.18	1.12½
October	.30 - .31	.26⅛- .26¼	.32- .34	.28 - .28½	.22½- .23	.19⅝- .19¾	.22- .23	.20	1.12½

* Old.

BARLEY.

[Per bushel.]

Date.	Boston.	New York.	Atlanta.	New Orleans.	Cincinnati.	Chicago.	St. Paul.	St. Louis.	San Francisco (per cental).
1891.	*No. 2, C. W.*	*No. 1, Canada.*			*No. 2, Spring.*	*Choice.*	*No. 2.*	*Prime.*	*No. 1, Cheval'r.*
August					$0.75-$0.78	$0.55-$0.60	Nominal		$1.65
September					.70- .72	.60- .68			1.37½
October					.68- .70	.40- .56	$0.55-$0.57	$0.50-$0.60	
1890.									
August	†$0.62					.62- .65			$1.40- 1.45
September	†.68					.54- .65			1.50- 1.55
October	†.70	$0.95			.74- .75	.58- .70	.65	.72	1.50- 1.52½
1889.									
August									1.40
September	$0.85- .95				.70	.66	.55		1.45
October	.80- .90				.60	.45- .55	.55	.60	1.45

† Price for No. 1.

COTTON.

[Per pound.]

1891.		*Middling up.*		*Middling.*	*Middling.*			*Middling.*	
August	....	$0.08	$0.08	$0.07¾	$0.08¼	....	....	$0.07 13/16	....
September	....	.08 7/16	.08¼	.08	.08¼	....	....	.08	....
October	....	.08 11/16	.08½	.08⅜	.08¾	....	....	.08 7/16	....
1890.									
August	....	.12¼	.10	.11¾	.12	....	....	.11½	....
September	....	.11	.10 11/16	.10¼	.11½	....	....	.10½	....
October	....	.10⅜	$0.08½- .09	.10 1/16	.10¼	....	....	.10	....
1889.									
August	....	.11⅝	.10⅝	.11	.11	....	....	.10¾	....
September	....	.11½	.11	.10⅞	.11¼	....	....	.11	....
October	....	.10⅞	.10½- .10¾	.10 1/16	.10⅞	....	....	.10¼	....

BUTTER.

[Per pound.]

1891.	*Extra creamery.*	*Stc. dairy best.*			*Fancy creamery.*		*Creamery.*	*Creamery.*	*Good to choice.*
August	$0.20	$0.17 -$0.18	....	....	$0.19-$0.20	....	$0.15-$0.16	$0.18	$0.22½-$0.26
September	.23- .24	.21	....	....	.26	....	.18- .20	.23	.22½- .26
October	.25- .26	.22½- .23	....	....	.26	....	.23- .24	$0.24- .27	....
1890.									
August	.19- .20	.16	....	....	.19- .20	....	.14- .16	.17- .19	.20 - .21
September	.26	.22 - .23	....	....	.24- .25	....	.18- .20	.26	.22½- .25
October	.25- .26	.20 - .21	....	....	.25	....	.18- .20	.18- .19	.26 - .30
1889.									
August	.20	.17 - .17½	....	....	.18- .20	....	.14- .15	.14- .16	.18½- .21
September	.21- .22	.17 - .18	....	....	.20- .21	....	.14- .17	.17	.22½- .24
October	.25- .26	.24	....	....	.26- .27	....	.18- .22	.20- .25	.26 - .28

Wholesale prices of agricultural products at leading cities in all sections of the United States—Continued.

EGGS.

[Per dozen.]

Date.	Boston.	New York.	Atlanta.	New Orleans.	Cincinnati.	Chicago.	St. Paul.	St. Louis.	San Francisco.
1891.	*Eastern extra.*								*Choice.*
August	$0.20	$0.17½–$0.18	$0.12½	....	$0.12½–$0.13	$0.14½–$0.15	$0.14 –$0.15	$0.11	$0.27½–$0.30
September	.20	.19½– .20	$0.18– .20	....	.16 – .17	.16 – .16½	.13½– .14	.16	.29 – .30
October	.22	.22	.19– .21	....	.17	.18 – .18½	.16 – .17	.16½	....
1890.									
August	$0.20– .21	.19	.15	....	.11½– .12	.12 – .13	.15 – .19⅓	.10½	.22½– .25
September	.22	.21 – .21½	.16	....	.16	.15 – .16½	.15 – .19⅓	.13½	.37½
October	.23	.22½	.20	....	.17 – .17½	.17½– .18½	.17½– .18½	.16½	.34 – .36
1889.									
August	.17– .18	.15½	.14– .15	....	.11	....	.11⅔– .12	.10	.30
September	.20	.19½	.19– .21	....	.14	....	.13⅓– .14	.12½	.32½
October	.23– .24	.24 – .24½	.18– .20	....	.16½– .17	.15 – .15½	.18 – .19	.14½	.40

Wholesale prices of agricultural products at leading cities in all sections of the United States—Continued.

TOBACCO.

Date.	New York.		St. Louis.			
	Pennsylvania seed leaf.		Missouri Burley leaf, medium to good.		Old-style leaf, medium to good.	
1891.	*Per pound.*		*Per 100 pounds.*		*Per 100 pounds.*	
Aug. 1	$0.08½ to	$0.13	$7.50 to	$10.00	$5.50 to	$7.00
Sept. 1	.12½	.16	7.00	12.00	6.00	7.00
Oct. 1	.12½	.16	7.00	10.00	5.00	8.00
1890.						
Aug. 1	.08	.30	8.00	10.00	6.50	10.00
Sept. 1	.08	.30	7.50	12.00	4.00	8.00
Oct. 1	.08½	.13	7.00	10.00	5.00	7.00
1889.						
Aug. 1	.08	.30	8.00	12.00	6.00	7.50
Sept. 2	.08	.30	8.00	12.00	5.00	7.50
Oct. 1	.08	.30	7.50	10.00	5.00	6.50

Statement showing the exports of wheat and wheat flour for the years 1887 to 1891, inclusive.

Year.	Bushels of wheat.	Barrels of flour.	Total bushels of wheat.
1887	101,971,949	11,518,449	153,804,970
1888	65,789,261	11,963,574	119,625,344
1889	46,414,129	9,374,803	88,600,743
1890	54,387,767	12,231,711	109,430,467
1891	55,131,948	11,344,304	106,181,316

Prices of live stock in Chicago market.

[Per 100 pounds.]

	Hogs.		Cattle.			Sheep.	
	Light.	Heavy packing.	Choice to fancy.	Good to choice.	Butchers' steers.	Westerns.	Natives.
1891.							
Oct. 2	$4.10–$5.00	$4.75–$5.35	$6.00–$6.25	$4.60–$5.90	$3.60–$4.30	$3.50–$4.45	$3.50–$4.90
Sept. 1	4.85– 5.75	5.00– 5.45	5.90– 6.30	4.90– 5.80	3.75– 4.40	3.50– 4.50	3.50– 5.10
Aug. 4	4.90– 5.90	5.10– 5.70	5.70– 6.25	4.90– 5.60	3.75– 4.40	3.50– 4.80	3.75– 5.25
1890.							
Oct. 4	4.10– 4.70	4.10– 4.60	4.65– 5.15	4.15– 4.70	3.00– 3.40	3.25– 3.90	3.25– 4.90
Sept. 2	3.90– 4.60	4.10– 4.55	4.75– 5.20	4.00– 4.65	3.00– 3.50	3.25– 4.40	3.25– 4.80
Aug. 2	3.70– 3.95	3.70– 3.85	4.25– 4.75	3.60– 4.20	3.00– 3.50	3.25– 4.65	3.50– 5.00
1889.							
Oct. 1	4.20– 4.85	4.05– 4.40	3.80– 4.75	3.00– 3.70	2.75– 3.25	3.25– 4.30	3.50– 4.75
Sept. 3	3.95– 4.70	3.70– 4.10	3.75– 4.70	3.00– 3.70	2.60– 2.90	3.25– 4.10	3.40– 4.65
Aug. 3	4.25– 4.60	4.20– 4.40	3.75– 4.65	3.00– 3.60	2.60– 2.90	3.25– 4.10	3.50– 4.75

CROP VALUES OF THE YEAR.

The extraordinary fact concerning crop values of the year, at least as to cereals and meats, is that they are so well sustained in the presence of abundant yields. Corn is so far higher than in last October, and the increased quantity, at current values, makes the increment of value from two to three hundred million dollars.

Wheat, with a crop almost 50 per cent greater than last year, and the largest yield ever recorded in this country, and the largest product ever harvested in any country, commands about the same prices in the great markets as last year. Oats are lower, with immense increase of production. Barley has held its value in the face of a large crop on an enlarged area, as the new duty has kept out a large part of the usual imports, and at least a portion of the duty on the little imported has been virtually paid by the foreign growers.

The increased value of all cereals over that of last year, on the basis of October values, is not less than $500,000,000.

The increased value of meats over those prevailing in October of last year is about 15 per cent on export values of beeves and meats exported, and 15 to 20 per cent on Chicago prices of beeves of different grades. The increase in wholesale values of all meats, on the basis of current prices, may reach $150,000,000. Cotton is lower this year. The large product and good prices of fruits will more than double fruit values of last year.

Taking all products together, in comparison with last year at prices current in October, the aggregate increase of value can not be less than $700,000,000.

AGRICULTURAL EXPORTS.

A review of our exports of agricultural products during five years past shows that the exports of 1891, following the bad crop year of 1890, are larger by more than $12,000,000 than those of the preceding year, and $100,000,000 in excess of those of 1889. Had our exports of breadstuffs in 1891 been as large as those of the previous year, the agricultural exports of the fiscal year just closed would have exceeded $650,000,000, or more than our total exports of all domestic products in any year prior to 1878. The indications now are that our sales abroad of the surplus from our farms will, during the present year, largely exceed the trade of any previous year.

During the first three months of the present fiscal year our exports in cereals alone have aggregated in value over $76,000,000, made up as follows:

	Quantity.	Value per unit of quantity.	Value.
Barley .... bushels..	490,650	$0.64	$315,440
Corn .... do....	7,097,342	.66	4,708,247
Oats .... do....	528,915	.41	218,253
Rye .... do....	4,269,936	.93	3,956,784
Wheat .... do....	50,414,889	1.05	52,734,641
Flour .... barrels..	2,828,743	5.11	14,449,262

For the corresponding period of 1890 the total exports of these products aggregate but $28,278,120, at values per unit of quantity as follows:

Barley	$0.65
Corn	.48
Oats	.37
Rye	.61
Wheat	.92
Wheat flour	4.73

AGRICULTURAL IMPORTS.

An examination of our imports for the period, October 1 to July 31, 1889–'90, and 1890–'91, affords an interesting comparison of trade in agricultural products during the first ten months under our present law, and for the same period during the last year of the old law. The total purchases have increased $28,000,000, but an analysis shows that the competition with our own agriculture has sensibly diminished under present customs regulations. This increase is confined to the free list or articles not competing with our production. Sugar, free of duty since April 1, 1891, contributes $20,000,000 increase; tea, coffee, and cocoa, $15,000,000; vegetable fibers, $3,000,000. The change in rates has at the same time checked the importation of products which may be produced at home, and to this extent stimulated prices and production here. Tobacco is a notable example, only $6,000,000 coming during the last ten months, against $17,000,000 during the preceding period. The competition of Sumatra leaf has been largely done away with, and as a result the price of Connecticut seed-leaf fine wrappers in New York on October 1 is quoted at 25 to 42½ cents per pound, against 22 to 37½ in 1890, when the provisions of the new tariff were already known and about to go into effect, and 18 to 32½ in 1889, when the old competition was in full force. Foreign purchases of barley show a falling off of nearly $3,500,000, and eggs more than $1,250,000.

A noticeable falling off in the import of horses (from 3,380,529 to

1,903,049), and a gradual falling off in the imports of all live stock, suggest that our present system of inspection, and the law which prohibits the introduction of any but pure-bred stock, duty free "for breeding purposes," is having the effect designed, of excluding a large number of animals of a class heretofore fraudulently introduced duty free.

The large quantities of hides which are being shipped to the United States from foreign countries, and are admitted free of duty, have caused a great depreciation in the prices realized for hides of domestic production. This has had a marked tendency toward keeping down the price of cattle, and has consequently added to the burdens of our agricultural population. I would therefore most earnestly recommend that the duty provided for in section 3 of "An act to reduce the revenue and equalize duties on imports, and for other purposes," approved October 1, 1890, be imposed in all cases where the countries from which such hides are shipped have not granted equal concessions in regard to the admission of the agricultural products of the United States.

MEAT PRODUCTS ABROAD.

The withdrawal by some of the foreign governments of restrictions which weighed heavily upon one of the most important of our agricultural industries—the animal industry—in response to the prompt and efficient performance by this Department of the responsible duties of inspection imposed upon it by the legislation of the last Congress, is one of the most gratifying features it is my duty to record in this report.

The action of the Governments of Germany, Denmark, and Italy in this regard deserves more than a passing word of congratulation, especially as this course seems likely to commend itself to other nations in Europe with whom we have reason to believe a large trade in this product could be built up. In the first place, it is becoming that the head of this Department should acknowledge in fitting terms, on behalf of his own Department, as well as on behalf of the important interests confided to his care, the warm personal interest ever accorded by yourself to all matters relating to the agricultural industry which I have had occasion to submit for your consideration, and without which this grand result could never have been attained. I should also not fail to acknowledge the cordial coöperation of the Department of State and of those diplomatic representatives abroad who have so intelligently and earnestly presented this subject to foreign governments.

In the second place, I want to emphasize, in referring to this subject, the beneficent effects of the wise extension of the powers conferred upon this Department, as affording not only a most gratifying recognition by foreign governments of the efficiency of the work of the Department, but as furnishing, in my opinion, a striking illustration of one method by which the interests of the farmer can be legitimately fostered by the National Government. It should therefore serve as an incentive to further efforts on similiar lines.

INSPECTION OF ANIMAL PRODUCTS.

The interest of our people in meat inspection has been great and has been increasing for years. With the concentration of the great bulk of the slaughtering business in a few large cities, where it is conducted on an enormous scale, the feeling became strong that there should be more rigid supervision for the protection of the health of consumers than was given by the local authorities where the abattoirs were located. This feeling found expression in legislation in various States, designed to secure the inspection of meat introduced from beyond their territory. On the ground, however, that such laws proved to be to a greater or less extent a regulation of interstate commerce, they were in most, if not in all, cases held to be unconstitutional, and the desired object was not accomplished.

In addition to this very natural desire of our own consumers to be protected from all real or fancied dangers to their health, there were to be considered the fears excited abroad by alarming, though unfounded, statements of sensationalists and others interested in injuring our export trade. If we were to keep our foreign markets it became evident that we should not only send to them the very best of meats, but that these should be accompanied by evidence that they had been properly inspected and that the animals from which they came were perfectly sound, and free from any taint and infection.

In the light of these conditions the last Congress passed the act of March 3, 1891, providing for the inspection of live cattle, hogs, and the carcasses and products thereof, which are the subjects of interstate commerce, thereby giving authority for an inspection of animals and meats as comprehensive and thorough as exists in any part of the world. This inspection has been organized in the chief centers of the business, and is being extended as rapidly as possible. The reports of the inspectors have confirmed the statement made in my previous reports that our pork and beef, produced as it is from the meadows and cornfields of a salubrious country, can not be surpassed by similar products from any section of the world.

As is the case in every country, however, there are some diseases affecting food-producing animals in the United States, which make it necessary that this inspection should be maintained for sanitary reasons. The disease known as tuberculosis, which exists in all parts of the world, particularly among neat cattle, is believed to be dangerous to the consumers of the meat and milk of affected animals; and the presence of this disease alone should be a sufficient reason for an inspection which would guard against the sale of the tainted products of such animals. But our people demand something more than protection from communicable diseases. From being long accustomed to markets having a surplus of meats, even our working people purchase the best cuts from healthy animals, and they would not knowingly accept for

food at any price the flesh of animals that were feverish from injuries received during transportation or from any other causes. In other words, the people of this country demand good meat from perfectly sound animals, and they would not tolerate the sale of meats from animals affected with even noncommunicable maladies.

In most, if not all, European countries inspectors, according to their reports, freely pass for consumption the meat of animals affected with foot-and-mouth disease, pleuro-pneumonia, localized tuberculosis, actinomycosis, and similar diseases which, according to the views and customs of this country, must be condemned. But all the meat for the foreign market is inspected the same as that designed for home consumption, and consequently has been much more rigorously dealt with than is the meat produced in the countries to which it is shipped. In this respect, as in others, we have met the objections which have been raised to American products, and have not only removed the cause, but have gone beyond what was asked by our critics.

The meat-inspection law has been to a certain extent misunderstood by people who apparently have not taken into account the peculiar features of our form of government, and who have thought that this Department should have been given specific authority to destroy the carcasses of condemned animals. While such an opinion is gratifying when coming from our own citizens in so far as it demonstrates their interest in a strict enforcement of the law, it seems to have been the conclusion of Congress that such action is beyond the powers of the Federal Government. Being a national law, this is looked upon as a measure for the regulation of interstate and foreign commerce, but not a local police regulation. It provides the means of guaranteeing the wholesomeness of meats shipped from one State to another or to foreign countries, but it does not provide a guaranty as to the condition of all animals slaughtered for local consumption, since the meat from them is in no sense an article of interstate commerce. It is therefore, under the law, the duty, as heretofore, of State and municipal authorities to inspect meat for local consumption and to deal with that which is condemned by the national inspectors as improper for shipment to other States. Nevertheless, in order to prevent any possible cause for objection to the system, this Department has required an agreement to be signed before inspection was commenced at any packing house to the effect that all condemned carcasses should be sent to the rendering tanks, where they are manufactured into fertilizers.

A system of inspection for all articles of food is extremely desirable, and this should, where possible, be conducted by local authorities. This is particularly necessary in the case of milk, which is liable to contain the germs of tuberculosis, and possibly of other diseases. To obviate the danger from this article of food, the dairies should be kept under strict supervision by the local sanitary authorities, aided by the National Government in cases where the dairy is not in the same State

as the consumer, and is, for that reason, beyond the jurisdiction of the local officers who are interested in its wholesomeness.

In connection with the financial side of our inspection work, it is desirable to compare the advantage gained with the cost of the work undertaken. I will not, at this point, go into details, which will be found in the more extended report on the work of the Bureau of Animal Industry under that head. I will simply state here the fact that, short as the time is since the inspection was established, I find the expense to be less than was anticipated, and to have been rapidly reduced, as might have been expected, as the work has been extended. While in the aggregate it will amount to a considerable sum, requiring a largely increased appropriation for the work of the Bureau, it will, I am sure, be less than most people would naturally expect in view of the enormous amount of work involved. As to the advantage gained, it can only be justly estimated by tracing the development of our foreign trade in animal products, especially in pork, during the ten years prior to the date when the prohibition on these products was enforced by European countries; and comparing that with the development during the past ten years while the prohibition was in force, the inference is a natural and perfectly just one, that without such obstacles in the way of this trade, its growth during the ten years just elapsed would have continued on the same scale as for the ten years previous.

A presentation of these figures shows, referring only to our pork products, that of these there was exported in 1871, $12,429,000, a sum which had increased in 1881 to over $69,000,000, exclusive of lard, which is not taken into account, as it has never been included in the prohibition. Instead of an increase since 1881 up to the present time, we find a great reduction, the exports for the fiscal year ending in 1891 aggregating but $50,494,375. It is a natural inference that the prohibition against these products by European countries caused our pork raisers last year a loss of foreign trade of about $20,000,000. As against the annual expenditure then for meat inspection, it is reasonable to expect a gain in trade at least equal to the annual loss imposed upon our pork raisers during the past ten years by the prohibition which efficient meat inspection can alone remove, and which for the whole ten years will aggregate over $260,000,000.

The condition of our live cattle and meat products is so satisfactory as to make all existing restrictions, such, for instance, as that imposed on our live cattle by the British Government, a grave injustice, working a grievous loss yearly to the agricultural classes in this country. We have a system of inspection of every live animal coming into this country, which, in addition to the absolute control exercised by this Department over communicable animal diseases in this country, enables us to offer the most perfect guaranty against the transmission of communicable diseases of cattle to other countries through the shipment of cattle from the United States. We have shown in all respects a will-

ingness to undertake any responsibility and to enforce any regulation of a reasonable nature which the prejudices or experiences of foreign countries suggested, and, as has already been explained, we are, in the matter of inspection, more rigid and thorough than our friends on the other side of the water. The complaints of ill treatment of animals on board ship have been met by the passage of a special law authorizing the officers of this Department to inspect every vessel loading cattle in American ports, and to enforce such regulations as in the opinion of the Secretary of Agriculture are essential to the proper care and good treatment of the cattle in transit.

As regards the possibility of danger to cattle abroad from Texas fever, while the increased powers which I shall ask for for the regulation of the Southern cattle trade in this country will, I am convinced, enable me to prevent any cases of Texas fever among cattle shipped abroad, still, it should be remembered that there is no possibility of this disease being conveyed to foreign countries, it being well known that while Southern cattle communicate the disease to Northern animals, these latter do not further spread the disease. We have convinced every reasonable man in Great Britain, as the result of the double check established by me something over a year ago, by which every animal shipped across the water is tagged and numbered so that it can be identified and its antecedents and history traced on this side, and by which it is duly inspected on arrival in Great Britain by inspectors detailed for that purpose from the force of the Bureau, that there is not an iota of danger to British cattle from contagious pleuropneumonia attributable to our live cattle exported. But three allegations of cases of this disease among American cattle landed in Great Britain have been cited by the British authorities, each of which was disputed by our American inspectors, and in only two cases of them did the British authorities adhere with some firmness to their diagnosis. Thanks to our system of identification, these two cases were traced in the manner I have indicated, and in every particular their life history sustained the diagnosis of our inspectors, which was, I should say, supported by many of the leading veterinarians in Great Britain at the time.

More recently, I am pleased to say, confirmation of our position in these cases, furnishing a triumphant vindication of our American inspectors, has been offered through the columns of a leading veterinary journal in Great Britain by the man who stands beyond dispute at the head of the veterinary profession in that country, and who confirms in the strongest manner our contention of the occasional existence of a disease of a pneumonic, but noncontagious, character among our cattle shipped abroad, as the result of exposure from a transatlantic journey in the winter, and he furthermore shows that in analogous cases among cattle landed in France and investigated by the leading French veterinarians our position was sustained and the disease pronounced

noncontagious, even without the intervention of an American inspector. These facts, in my opinion, would amply justify this Government in making to the British Government the strongest presentation of the grievance which our cattle-raisers suffer unjustly at their hands, by reason of the arbitrary regulations enforced against our American cattle in British ports owing to an alleged dread of contagious diseases, coupled with an urgent demand for the removal of obstacles which we have clearly shown to be useless, and the maintenance of which can only be regarded as an evidence of unfriendliness. Justice as well as proper self-respect demand such a course.

Unless we can secure from the British Government the removal of the unfriendly restrictions now bearing so hardly upon our cattle trade, I shall feel it to be my duty to suggest the rigid enforcement of the law now in existence prohibiting the import into the United States of all live animals, a law which has only been suspended as a matter of friendship to foreign governments. That we have far more justification for the exclusion from the United States of all animals coming from Great Britain and its dependencies than they have for the interposition of any obstacles to our cattle exports from the United States, is shown by the recent report of Prof. Brown, the veterinarian of the British Privy Council, who admits in the plainest manner that no hopes exist in that country of ever absolutely suppressing pleuro-pneumonia, and shows, indeed, that such measurable success as he has faint hopes of attaining in the control of it is to be obtained only by methods which are nothing more than those adopted by ourselves and to which, promptly and vigorously enforced, we owe our present success in the complete control of this disease.

MARKETS FOR AMERICAN FARM PRODUCTS.

Already those laws under which you have been able to enlarge so wisely the channels of foreign trade as the result of reciprocal concession hold out to American agriculture hopes for such a demand for our agricultural products as would have been deemed but a few years since absolutely chimerical. Recognizing the importance of these measures and the extent of the opportunity thus afforded us, I have already sought to furnish the country with the fullest information obtainable in regard to the agricultural resources of other countries and the probable character of the demand which it may be in our power to supply. My facilities for carrying on this work, based on appropriations estimated for when comparatively little opportunity existed for the furtherance of such plans, have been necessarily inadequate, but the necessity of extending work in that direction is so obvious, and the advantages to be obtained by its maintenance and development so great, that I feel confident of encouragement in the way of liberal appropriations for carrying on all the work which I have planned for this Department in the development of our markets abroad.

In furthering the interests of our agricultural products in foreign countries it is especially desirable to propagate by every legitimate means a knowledge among the peoples of foreign countries of our own resources and our own facilities for supplying their wants. Our largely increased facilities in the way of transportation must be accompanied by a freer intercourse, which will teach them the value of our products for their own wants. It will not do for us to overlook the fact that in every foreign country to which we look for the disposal of some of our surplus products we will necessarily meet with a class or classes whose interests will clash, or seem to clash, with ours. In cases where this is only imaginary, the imagined obstacles can only be done away with through a better knowledge among those people of the conditions of agriculture among us, while in the cases where a real competition exists we shall find ourselves obliged to combat not only legitimate competition, but an antagonism which will seek to create prejudice in the minds of consumers against American food products. This can be met only by addressing ourselves directly to the consumers in these foreign countries, whose real interest lies in obtaining desirable supplies of a satisfactory character and at reasonable prices. When once we succeed in inspiring the majority of consumers in any country with confidence in the character of our products and to convince them of the availability for their use of what we have to sell, the antagonism of a single class in a community will be unable to successfully oppose our efforts for a share of their trade. A striking example of the benefit of adequate representation abroad in the interest of agriculture is afforded by the work of our American inspectors of live stock in Great Britain, to which reference has already been made.

CORN IN EUROPE.

A further example of this kind has been furnished by the intelligent and earnest work of the special agent whom I appointed something over a year ago for the purpose of introducing our corn products to the attention of the people of Europe as a nutritious and economical substitute for other cereal foods. The disposal of this, one of our largest crops, abroad has been fitful, being utilized by foreigners almost exclusively as a cattle food, and its extent consequently depending not so much upon any demand abroad as upon its cheapness with us. Hence in years of large production, while the amount exported has shown an increase, it has been at prices inadequate to insure a profit to the producer, while a rise in price, consequent upon a small crop, has always greatly reduced the exports. The efforts of our special agent have been devoted to an attempt to disseminate as widely as possible a knowledge of the various preparations from Indian corn, so popular in this country as human food, and adapted, as all Americans well know, to provide a cheap and inexpensive diet for the poor, as well as to furnish the table of the rich with many delicate and palatable dishes. In

this he has been, in my opinion, rarely successful. It is true that his work has been, until recently, principally confined to Great Britain, in which country he has been greatly aided by the existence in almost every town of any consequence of cooking schools, whose teachers have shown themselves most ready to receive his instructions and adopt his suggestions. Charitable societies and boards intrusted with the care of public institutions have also greatly assisted him in his work.

A report of his work in Great Britain has been received, and will be shortly published, together with a chapter prepared by the chemist of the Department on the chemical composition of corn and its value for food purposes by comparison with other cereals, and also a statistical chapter giving the figures of our corn area and product for a series of years, with prices, proportion exported, etc. This work has attracted much attention in this country, and many of our influential citizens have shown a disposition to further his efforts by all legitimate means, while one of our public-spirited German-American citizens proposes to establish in Berlin, for the benefit and instruction of his countrymen in the uses of Indian corn and its preparations, a practical school of instruction, or corn kitchen. Some time ago, when it became apparent that there was a considerable shortage in the rye crop of Europe, I sent our agent, Col. Murphy, to Berlin with instructions to visit not only Germany, but other countries as well, in which an opportunity existed for his work, for the purpose of taking advantage of the short rye crop and the high prices of other grains, to introduce to the attention of the people on the Continent the availability of corn meal and other corn preparations as a substitute, or at least an adjunct to the wheat and rye foods common among them. He has already succeeded in calling the attention of the German Government to the availability of this cereal as a part of the army rations, it having been found that an excellent mixed bread of rye and corn can be made far more cheaply than bread from rye alone.

DISPOSAL OF SURPLUS CROPS.

It is not to be inferred that because I lay such stress upon the extension of the market for our agricultural products abroad, I overlook the fact that our exports of agricultural products, large as they are, form but a comparatively small percentage of the total crop. This I fully appreciate, and that portion of this report devoted to a general review of the work of this Department in our own country will furnish sufficient proof of this fact; but I realize also that, with our marvelous facilities in the way of agricultural production and our wonderful diversity of soil and climate, and the extent of our territory, we must for many years expect to raise a surplus of many kinds of crops, and in most cases the profitable disposal of this surplus means not only the maintenance of a balance of trade in our favor and many millions of dollars paid to our farmers by foreign consumers, but it must always have a sensible effect

in maintaining remunerative prices for the large proportion of the crop consumed at home.

THE MIDDLEMAN.

In considering the wants of our farmers in relation to the home market, the opportunities for extended observation in relation to prices of agricultural products which the duties of my present position afford me have confirmed me in the strongest manner in my previously formed impressions in regard to the excessive difference between the prices paid for agricultural products in the market by the consumer and those paid on the farm to the producer. This is a serious evil, enhancing the cost of living to our people, while it depreciates the value of our crops to the farmers. A large share of this difference in price is to be attributed to the handling of the product from the time it leaves the farm until it is delivered to the consumer. The condition of our farmers living in the country away from a market center and obliged often to spend an entire day in order to deliver one load of produce at the nearest market or station, and the general tendency of our people to transact business in the quickest way possible, gives to the middleman a prominence and an influence greater than he probably possesses in any other country.

To provide an adequate remedy for this evil is not an easy task, but there is one thing which can be done for the benefit of both producer and consumer, and this duty clearly devolves upon this Department. It is, to keep the public thoroughly informed on the matter of prices of all important farm products. Doing business daily at a market center, the middleman knows what prices he can obtain, and his rule in purchasing—to get the goods he deals in as much below that price as possible—is greatly subserved when he deals with a seller ignorant of the true value of his goods. My earnest efforts have been directed to placing promptly in the farmer's hands the fullest information in regard to the market values of his wares, which will at least save him from the penalty of ignorance and the unscrupulous greed of traders. To extend this work until every farmer in the country may know before he markets his goods just what their value is in the nearest market, is my earnest desire and intention.

DIVERSIFICATION OF CROPS.

In regard to our home market, our chief dependence for its development beyond present limits must be, as I have previously taken occasion to state, in such a diversification of our agricultural products as will enable the American farmer to supplant the foreign one in supplying a large proportion of the agricultural products which we now import. In reviewing the agricultural imports of the past ten months, and noting with satisfaction the effect upon some of them of our present tariff law, it was, nevertheless, strikingly apparent that many

of the agricultural products imported were of a character which could be, and should be, produced in this country.

HOME-GROWN SUGAR.

With regard to the most important of these—sugar—the efforts of this Department afford much encouragement for a home-grown sugar product. The results of the work of the experiment station established in the interest of beet sugar may be regarded as eminently satisfactory, and with regard to sorghum I am happy to be able to state that the process known as the alcohol process, perfected in the chemical laboratory of this Department last year, has, on being tested in the practical manufacture of sugar, answered all reasonable expectations. It is found to so greatly facilitate the extraction of the sugar from the cane as to practically double the yield obtainable by the methods heretofore employed, and this at an increase of cost so trifling as to be practically insignificant. There seems to be no reason why we should not, therefore, look forward with confidence to the day when the one hundred millions of dollars paid by Americans to foreign sugar producers should be turned into the pockets of our own people.

TRANSFER OF THE WEATHER BUREAU.

In all efforts toward diversification in our home-grown products, climatic conditions must be well understood and considered, and in this connection the importance and value to the agricultural interests of the control by this Department of the Weather Bureau can not be exaggerated. On the 1st of October I called upon the Chief of the Weather Bureau, appointed by you July 1, for a special report covering the first three months of his administration of the office, in order that the public might understand the trend of the plans upon which we have agreed for the purpose of enlarging and extending the work of the Bureau, especially in aid of our agricultural interests. Such a report was duly prepared and is now in print, and while the time has been too short to speak of tangible results, the report, nevertheless, shows very clearly the extension of the work in the direction indicated. It is further to be noted with gratification that the transfer of the Bureau to this Department has been generally received with great satisfaction. There has been a truly remarkable development of interest in the work of the Bureau, resulting in a great increase of stations—from 600 to 1,200—as well as of voluntary observers throughout the country, these numbering 2,200, an increase in three months of 400.

At the recent meeting of the Association of American Agricultural Colleges and Experiment Stations, Prof. Harrington bespoke their coöperation in meteorological work, and his suggestion, I am glad to say, was met with a hearty and prompt response, resolutions being adopted expressive of the sense of the association that every college and station should coöperate in the work, and that the closest relation

should be established between the Weather Bureau and such institutions. I take this opportunity to congratulate you upon the selection made for the important post of Chief of the Weather Bureau, and to express my appreciation of the earnest manner in which Prof. Harrington is laboring for the improvement of the service in perfect sympathy with the lines suggested by me in my last Annual Report.

FARMERS AND THE DEPARTMENT.

The demand which exists for more frequent and intimate intercourse between the farmers and the Department can not be met altogether by the issue of bulletins. The printed document, however valuable, may be interesting and instructive, but can never take the place of personal contact. The intercourse between the Department and the farmers should be reciprocal and not one-sided, and such an intercourse can only be cultivated by the frequent participation of representatives of the Department in the meetings of the numerous agricultural societies and farming associations, at which the farmers themselves are present to discuss the means necessary for the improvement of agriculture. I am happy to say that the need for closer relations of this character seems to be appreciated quite as much by the farmers as by myself, as the increased demands for the representation of the Department at meetings of that description amply testify; indeed, they far exceed my ability to comply with them. I trust that in the near future my facilities in this respect may be greatly enlarged. The general and growing interest shown by all classes in this country in the cause of agriculture and in the work of this Department is becoming daily more manifest. It is seen in the attention devoted to the work of this Department by the public press, including many of the leading magazines of the country, to whose pages a few years ago the subject of agriculture was practically an entire stranger. It is to my mind a most hopeful sign that the minds of Americans generally, especially of those who are devoted to other pursuits, should be inclined to give to agriculture the attention it deserves, and to acquaint themselves with its needs and condition. In connection with this subject I desire to call attention to the interesting series of meetings of various scientific associations in Washington this past summer.

IMPORTANT MEETINGS.

During the months of August and September there were convened in the city of Washington ten scientific associations, in whose work this Department has a large interest, viz: The American Microscopical Society, the Association of American Agricultural Colleges and Experiment Stations, the Association of Official Agricultural Chemists, the Society for the Promotion of Agricultural Science, the Conference of American Chemists, the Association of Economic Entomologists, the American Association for the Advancement of Science, the Geological

Society of America, the International Congress of Geologists, and the American Pomological Society.

Never before in the history of the United States has there been such a convention of scientific students in any one place. Their researches cover almost every phase of scientific inquiry and are full of practical results in almost every branch of domestic economy and human industry, while, as the names of many of them indicate, a large majority of them are devoted especially to the consideration of subjects entering directly into the domain of practical agriculture, and in every one of them, I am gratified to be able to state, questions of vital interest to agriculture received ample consideration. As a natural consequence, the scientific force of the Department had occasion to participate, in some cases largely, in the deliberations of these important associations, and to enjoy the inestimable advantage of personally meeting and conversing on subjects related to their own work with the leaders of scientific thought and research in the country. Moreover, I was especially gratified over the fact that at these gatherings the representatives of the Department were treated with a consideration that fully indicates the appreciation in which the work of this Department is held by the scientific world. In this connection it is proper to acknowledge the great value to agriculture of the six lectures delivered at that time by Mr. R. Warington, F. C. S., before the Association of American Agricultural Colleges and Experiment Stations, as the representative of the agricultural experiments of Lawes and Gilbert, at Rothamsted, England. Mr. Warington was the first representative of Rothamsted under the new trust of Sir John Bennet Lawes to Rothamsted, which provides that a representative shall visit America every three years as an exponent of Rothamsted and its work. Mr. Warington met a most cordial welcome, not only from this Department, but from all the leading agricultural scientists in attendance upon the meetings of the association. The lectures were of such high merit that I have authorized their publication by this Department as a portion of the proceedings of the association.

COÖPERATIVE WORK.

Before leaving this subject I desire to express my conviction of the necessity for a closer coöperation between the various educational forces which already exist in this country for the advancement of practical agriculture. The thread which connects this Department with the agricultural colleges and stations, themselves to-day recipients of the national bounty to the extent of considerably over a million and a half dollars annually, is a very slight one. It seems to me desirable that, without in any way limiting the independent action of these several State institutions, the connection should nevertheless be greatly strengthened. These institutions have themselves felt the need for coöperation, and deserve the credit for being the first to adopt some systematic method of attaining it, but this effort is limited to them-

selves. In addition to these institutions we have some individual, or board of individuals, representing in a special manner the agricultural interests of the State, and we have, moreover, State and national societies devoted to the improvement of stock, to the interests of horticulture, dairying, and other specialties in the line of practical agriculture, together with the institutes established and endowed by law in several States. The efforts of this Department will be directed to an extension of some system of coöperation between these various forces by which each in its proper sphere may work to the best advantage, and each be enabled to derive practical aid and benefit from the others.

INTERNATIONAL ASSOCIATIONS.

Three meetings having close relations to agricultural interests have also been held in Europe during the past summer, and in accordance with the earnest desire expressed to you in my last report, that the United States should be represented at such international gatherings, I designated Dr. D. E. Salmon, Chief of the Bureau of Animal Industry, to represent this Department at two of them, namely, the International Congress of Hygiene and Demography held in London, August 10–17, and the International Congress of Agriculture, held at The Hague, September 7–12. The selection of Dr. Salmon to represent this Department at the first named was due to the fact that the congress devoted a large part of its attention to the relations of the diseases of animals to those of man, one section being assigned exclusively to the consideration of this important subject.

It gratifies me to be able to inform you that our representative was received at the congress with every mark of consideration, he having been elected an honorary vice-president of the section referred to on receipt of my advice of his appointment, and before he had even presented his credentials. He was also made a member of the foreign council of the section. His being in Europe, together with the fact that two of the important sections of the International Congress at The Hague, the third and the sixth, were devoted to subjects which, in this country, are assigned especially to the Bureau of Animal Industry, determined his appointment as a representative of this Department at The Hague congress also. The same flattering evidences of consideration were accorded to him as a representative of this Department at that congress, of which he was elected first vice-president, a distinction especially honorable in view of the fact that he was, I regret to say, the only representative from this country. I am satisfied that his presence there was in many respects most advantageous to our interests. The mere fact that he would be brought into personal contact at these gatherings with men who, in the several countries of Europe, are called upon to act as the scientific advisers of their respective governments in matters relating to agriculture, and especially in such matters as legislation against contagious diseases, inspection of food products, etc.,

would, of itself, in my opinion, amply justify his mission; indeed, I might say it was essential to our interests that he should be there.

The third association referred to above was the International Meeting of Meteorologists held at Munich August 11, at which this Department was represented by Prof. Mark W. Harrington, Chief of the Weather Bureau, and Prof. Cleveland Abbe, one of his chief assistants. In the annual report of this Department, which will go to press before the close of the year, I hope to include valuable reports in reference to all these meetings. I may say now, however, that this year's experience, and the practical effort made to secure adequate representation at meetings of this description of an international character, absolutely confirm me in my convictions already expressed to you, of the necessity of ample and intelligent representation of American agriculture on these occasions. I understand that the next meetings of these associations (they occurring biennially) will fall in 1893, and I regret that no one was authorized to extend to them an invitation to select this country as the place and the Columbian Fair as the occasion for their next meeting. I understand that there was an evident feeling at these gatherings in favor of meeting in 1893 in this country, and, further, that the decision of this question was left to the permanent executive committee. It is possible, therefore, that steps might still be taken to accomplish this end.

BUREAU OF ANIMAL INDUSTRY.

The passage by Congress of the act providing for the inspection of live stock and their products, approved March 3, 1891, and the act providing for the inspection of vessels carrying export cattle, approved March 3, 1891, has so increased the work of this Bureau that I found it absolutely necessary to divide it into four divisions, viz, the Division of Inspection, the Division of Animal Pathology, the Division of Field Investigations and Miscellaneous Work, and the Division of Quarantine.

To the Inspection Division was assigned work largely of an executive character, which covers the eradication of contagious diseases, the inspection of export and import animals, meat inspection, vessel inspection, and the regulation of the movement of Southern cattle.

ERADICATION OF PLEURO-PNEUMONIA.

At the time of my last report contagious pleuro-pneumonia existed in two districts in the United States, viz, on Long Island, State of New York, and in the county of Hudson, State of New Jersey. During the present calendar year but four herds have been found infected with this disease on Long Island, the last herd having been discovered and slaughtered on April 30, 1891. Six months have therefore elapsed since the finding of any cases of the disease in this district, and I am

satisfied that our efforts there in extirpating contagious pleuro-pneumonia have proved successful.

There still remains a small district in the State of New Jersey from which the infection has not been completely eradicated. The work there, however, is being pressed forward with the greatest possible energy, and I confidently expect that before the end of the present fiscal year I shall be able to announce the complete eradication of this virulent and destructive disease from the United States.

With only one small district infected, with this territory in strict quarantine, and with all herds promptly slaughtered when disease is discovered, there is no longer justification for any restriction whatever by the government of any country against the importation of cattle from this country.

INSPECTION OF EXPORT ANIMALS.

The inspection, by American veterinarians, of our cattle landed at the foreign-animals wharves in Great Britain has been continued during the present year with the most gratifying results. The total number of animals inspected by them from the time they began their work to September 19 of the present year was 374,415 head of cattle and 10,959 head of sheep.

The inspection of export animals in the United States has also been continued since my last report under the provisions of the act of Congress of August 30, 1890, and covers the inspection of animals at interior stockyards, the tagging of animals at these points with numbered metal tags, and the obtaining of a history of the animals at the time of tagging, the reinspection of these animals en route and at the port of export, and the loading of the same on board vessels. Since the commencement of this work 311,146 cattle and 15,373 sheep have been inspected, as provided by our regulations, up to October 1, 1891, making a total of 326,519 head of animals inspected.

Of these numbers—

	Cattle.	Sheep.
Great Britain received	300,862	13,714
Germany received	4,354	
France received	4,336	1,576
Belgium received	1,594	
Australia received		42
Cape Colony received		41
	311,146	15,373

The exports of cattle for the fiscal year ending June 30, 1891, show a decrease of 3¾ per cent compared with the exports for the fiscal year ending June 30, 1890. The total exports for 1891 amounted to 362,402, as against 372,690 for the preceding fiscal year. The cause for this decrease in exports is undoubtedly due to the increase in prices of cattle in this country during the latter part of the fiscal year; cattle bringing

in June, 1891, from $1.25 to $1.50 per 100 pounds more than in June, 1890.

The excellent impression which our cattle have made in Germany is shown by the following extract from an article which appeared in the German Agricultural Press (Deutsche Landwirtschaftliche Presse), Berlin:

On July 20, 139 head of cattle from the United States arrived at Hamburg; most of them oxen. On August 1 a similar shipment arrived, and on August 3 the steamer *Sorronto* landed 240 head; after a thorough inspection the cattle found ready buyers, and were mostly sold to butchers in Hamburg and Altona. They were killed after they had undergone another careful inspection in the public slaughter-houses. The quality of the cattle was excellent; all of them were young and well fed, and they had suffered but little during the time of transportation. It therefore can not be surprising that the prejudice that existed against American cattle by the butchers in Germany is gradually disappearing, and American cattle are preferred. The meat is excellent, as may be expected of cattle that were raised on the meadows. Bulls are less in demand.

The cattle show that the Americans take great pains in raising good stock, and it seems that the high prices they give in England for the best stock of cattle for breeding purposes repay them well. The most of these cattle are Shorthorns, some Scotch "Angus," and also Devonshire and Herefordshire; in short, those kinds of cattle which we see at the large cattle shows in England.

In comparison with the German cattle, it seems that the Americans succeed in giving their cattle a broader and deeper front, deeper and more complete hind-quarters, as well as a strong and straight back; in one word, the cattle have a fine appearance and make a favorable impression. The head is well and nobly shaped, but the horns, which are an ornament to the cattle, are mostly cut off. This seems to be a widespread practice in America, and that cruel operation generally takes place before the cattle are one year old, so that when the cattle are two or three years old one can hardly recognize even a stump of the horns. No doubt it is an advantage when cattle are to be shipped and many of them are loose in one compartment.

Whether the import of cattle from America will reach large dimensions remains to be seen, but it deserves the closest attention of our agriculturists and stock-raisers.

What the extent of the importation of cattle from America may be is seen by the export to England, where during last year in Deptford alone about 300,000 head of cattle were landed from the United States.

INSPECTION OF IMPORTED ANIMALS.

The act of August 30, 1890, provides for the inspection of all imported cattle, sheep, and swine arriving in the United States. This work was inaugurated by the Department immediately after the passage of the act, and has been continued in accordance with our regulations. Inspection stations have been established along the Canadian border, and three quarantine stations are maintained along the Atlantic seaboard. At the beginning of this work stations were established along the Mexican border, but since the increase in tariff duties on imported animals no importations of cattle, sheep, or swine were made into this country from Mexico, and for this reason these stations were discon-

tinued. The total number of animals inspected since the commencement of this work, imported at our Canadian stations, was 2,456 cattle, 129,390 sheep, and 54 swine. Of this number 169 cattle, 2,680 sheep, and 54 swine were imported for breeding purposes. At the quarantine stations on the Atlantic seaboard there were imported and quarantined for ninety days 46 cattle, imported for breeding purposes, and 1,698 sheep, and 70 swine, quarantined for fifteen days.

Owing to the failure of the Dominion of Canada to provide for the quarantine of sheep arriving in that country from countries infected with foot-and-mouth disease, I found it necessary, on the 19th of May, 1891, to order the quarantine of all sheep and swine imported from Canada into the United States for a period of fifteen days. Sometime thereafter, by order of council, a quarantine of fifteen days was established on all sheep and swine imported into Canada from Great Britain or the continent of Europe, and consequently, on June 25, 1891, I rescinded my order above referred to.

The only contagious disease found among imported animals at our quarantine stations during the past year was among a shipment of twenty-two Southdown sheep from England which entered at our quarantine station at Garfield, N. J., in which shipment were eleven animals affected with foot rot. This shipment was detained in quarantine until this disease had entirely disappeared. The only other instance of disease occurred in a shipment of sheep from Canada, imported at Island Pond, Vt., in which were found five cases of foot rot out of a shipment of 102 head. These were handled in the same manner as the sheep found diseased at Garfield.

VESSEL INSPECTION.

Under the act of March 3, 1891, this Department was empowered to regulate the fittings of vessels carrying export cattle from this country to foreign nations, and on June 6, 1891, I made such regulations as in my judgment would promote the better carrying of cattle, the more humane treatment of the same, and insure their arrival in better condition at their points of destination. I am happy to say that the various steamship companies engaged in this traffic have very cheerfully accepted these regulations, and, at considerable expense, have remodeled their vessels so as to comply therewith. The result, so far, of the vessel inspection regulations has been to materially reduce the losses resulting from lack of ventilation, overcrowding, and weak fittings. The carrying trade has thus been greatly benefited by these regulations, and hereafter losses from the causes just mentioned will be reduced to a minimum, and the objections to the transatlantic trade in live cattle entirely overcome. The total number of vessels examined since July 1, 1891, has been 215; 98 sailed from the port of New York; 52 from Boston; 42 from Baltimore; 15 from Philadelphia, and 8 from Newport News.

MOVEMENT OF SOUTHERN CATTLE.

The mildness of last winter made it necessary to undertake the control of Southern cattle coming to Northern markets at an earlier period than for the preceding year, and on February 5, 1891, I issued the necessary order regulating the movement of cattle in this branch of our interstate commerce. The quarantine line of the present year was extended from the Mississippi River east to the Atlantic Ocean, conforming as nearly as possible to the line of permanent infection by this disease established as a result of the investigations published in the report of the Bureau of Animal Industry for the year 1884.

Some idea of the amount of work done by the Bureau in supervising the movement of Southern cattle may be had from the fact that the total number of carloads of cattle which were separated and kept distinct in course of transportation amounted to 40,542, containing 1,051,626 head of Southern cattle.

It was not possible during the present season to maintain as rigid an inspection of the work of disinfecting cars, performed by the railroad companies, as was necessary to insure absolute safety in this traffic. The Department was compelled, in a measure, to rely upon the railroad companies for the observance of this part of the regulations, and for the thoroughness of the work. While a large number of the railroad companies cheerfully complied with the regulations and endeavored to carry them out thoroughly, I regret to say that others were careless in attending to this matter. The consequence, therefore, has been that while the outbreaks of Texas fever or Southern fever have been greatly diminished during the present season, they have still occurred in some parts of the country, and a few cases of the disease have been found among export cattle.

I have, therefore, to renew the recommendation made in my last report, that legislation be asked of Congress which will render possible the strict enforcement of the regulations for cleaning and disinfecting cars that have carried infected cattle. At present there is no penalty or provision of law by which railroad companies can be held to a strict compliance with this rule, and the only means at the disposal of the Department for securing this is to refuse to certify export cattle for clearance in cases where the regulations are disregarded. If the country is to be kept free from this disease it is necessary that specific power should be given this Department which will enable it to secure obedience to these regulations by all common carriers, whether they are interested or not in the export trade.

MEAT INSPECTION.

In prescribing regulations for meat inspection under the act of March 3, 1891, I made provision for a microscopic examination of hogs at the time of slaughter in order to certify that the same were free from the

animal parasite called *trichinæ spiralis.* In addition to the provisions for microscopic inspection of pork, the regulations provided for an examination, before and after slaughter, by veterinary surgeons, of all animals slaughtered for export or interstate trade, the condemnation of animals found to be diseased, and the proper identification of the carcasses and other products which enter into these two classes of our commerce.

Meat inspection was instituted under these regulations on May 12, 1891, in New York, N. Y., and was confined to the inspection of export dressed beef. At the beginning of June, 1891, this work was inaugurated in Chicago, and immediately thereafter at South Omaha, Kansas City, Jersey City, and Hammond, Ind. Microscopic examination of hogs was commenced in Chicago on June 22, 1891, and later at Milwaukee, Omaha, Kansas City, and Boston. From the beginning of this work to the 1st day of October, 1891, there have been a total of 1,016,614 animals inspected both before and after slaughter. Of this number 844,581 were cattle, 15,330 calves, 93,331 sheep, and 63,372 hogs. There were 373,149 quarters of dressed beef tagged for export and 2,009,462 for interstate trade. In addition, 379,872 packages of canned, salted, and smoked meats were stamped in accordance with the regulations. There were 63,372 carcasses of hogs examined microscopically. The total number of animals condemned and sent to the fertilizing tanks was 1,976.

COST OF THE WORK.

It is exceedingly difficult to estimate the cost of the new branches of work undertaken by the Bureau of Animal Industry during the past year. This difficulty is increased by the fact that the amount of work done each month and the cost of the same fluctuates with the demands of commerce for our cattle and their products.

The work of inspection of export animals provided for by the act of Congress of August 30, 1890, has now been in operation for about ten months. The average cost of this character of work during this period has been at the rate of $8,500 per month. During certain months it has gone as high as $10,279 and has fallen as low as $7,400. As an average, I should estimate that the cost of export-cattle inspection, which covers the work at interior stockyards, tagging, recording, and inspecting at the foreign animal wharves in Great Britain, would be $100,000 per annum.

The cost of maintaining the supervision of the movement of Southern cattle was at an average expenditure of $2,275 per month, or for the ten months during which the regulations are enforced $22,750. If a sufficient number of inspectors are employed to see that all cars are properly disinfected and that the regulations are enforced at all stockyards the annual expenditure will probably reach $30,000.

The inspection of import animals arriving in the United States from Canada amounts to $775 per month, or $9,300 per annum.

The work of meat inspection has only been fairly in operation since the commencement of the present fiscal year. The cost of the inspection of animals and carcasses in this work during the month of July, including the tagging of quarters of dressed beef going into the export and interstate trade and the stamping of packages of canned and salted beef and pork products, amounted to 5.7 cents per head for each animal inspected, making a total, for 195,664 animals in the month of July, of $11,160.71. This cost was reduced in the month of August to 4.75 cents per head, being a total number of 295,250 animals inspected at a cost of $13,981.39. A still further reduction in the cost of the work was accomplished during the month of September, when 438,593 animals were inspected at a cost of $14,200, an average of 3¼ cents per head. I am of the opinion that the inspection of animals and their marking for identification may be accomplished for a sum not exceeding 3 cents per head.

The figures given above do not include the cost of the microscopic inspection of hogs. This latter branch of the work has not been in operation long enough to be properly estimated for. It was necessary at first to educate examiners in the performance of their duties, and some little time was required to enable them to become proficient and rapid in their examinations. Another difficulty arose from the fact that several abattoirs which are being supplied with this character of inspection do not keep our examiners supplied with the quota of samples designated in their applications for this inspection. The cost of microscopic inspection during the month of July amounted to 20⅓ cents per hog. The cost of the same work during the month of August was reduced to 13⅓ cents per hog. Taking fifty animals as the average examined by each person, the cost of inspection would be about 5 cents per animal.

The demand for this inspection by the various packing and slaughtering establishments throughout the country is on the increase. Twenty-seven establishments are now having their products inspected, and there are a number of other applicants with whose requests I have not been able to comply, as the appropriation for the Bureau of Animal Industry is too small to justify extending this branch of work. I earnestly recommend that Congress be asked to make an appropriation sufficiently large to enable us to extend this inspection to all applicants. Doubtless this branch of work was not considered by Congress at its last session in making the appropriations for the Bureau of Animal Industry, as the bill providing for it was not passed until the closing days of Congress. The benefits which have already accrued by the opening up of the foreign markets to pork products, the increased demand for beef products, and the reëstablishment of their reputation for wholesomeness and soundness in the markets of the world, together with the protection which this inspection furnishes to our own consumers, amply justify a liberal appropriation.

DIVISION OF ANIMAL PATHOLOGY.

The Division of Animal Pathology, as at present organized, covers all investigations in regard to the nature, prevention, and treatment of animal diseases. During the summer considerable time had to be spent in fitting up the new laboratory provided for by the last Congress and in transferring apparatus to it. Though experimental work was not stopped at any time, it was more or less interfered with during July and the latter part of August. The new quarters are superior to the old in every particular, and are well provided with apparatus and modern appliances for this class of investigations.

The investigations of Texas fever have been continued during the summer. The results of the experiments confirm the conclusions of 1890, throwing new light upon the nature of the disease and strengthening the hope that its means of transmission will soon be fully understood.

The work on swine diseases has occupied the attention of the division throughout the year. A special report on swine plague was prepared with great care, which gives in detail the work done by the Bureau since 1886 in different parts of the country.

Inoculation as a means of preventing the diseases of animals, the different forms of pneumonia in cattle, and tuberculosis are among the subjects which have been carefully studied.

The investigation of animal parasites is being actively prosecuted with reference to our domesticated animals. These parasites are responsible for a large amount of harm, which is becoming more apparent by patient research. The material for a report on the animal parasites of cattle is now being collected.

Other diseases are being investigated as time and opportunity offer, and valuable work is being done in determining the essential cause of animal plagues.

DIVISION OF FIELD INVESTIGATIONS AND MISCELLANEOUS WORK.

A corps of inspectors is constantly employed in making investigations as to the character, etc., of reported outbreaks of contagious diseases in various States. As an example of the necessity and importance of such work, it may be stated that an unfounded rumor of the existence of foot-and-mouth disease was recently published in Pennsylvania in spite of the lesson derived from our experience in the West last year. Upon careful examination, however, it was demonstrated, as in the latter case, that this was not foot-and-mouth disease, nor a contagious disease at all. The contradiction in this case followed the rumor so quickly that it is hoped no evil consequences to our cattle interests will ensue, but such unfounded rumors are as dangerous as they are inexcusable. There has been less disease of all kinds than formerly among our animals, and happily many of the contagious diseases common or occasional in other countries do not exist at all with us.

I take pleasure in calling your attention to the great value of, and unprecedented demand for, the Special Report on Diseases of the Horse, written by the most eminent veterinarians of this country, and issued by my direction. If we may judge by the character of letters received commending this publication, it is within bounds to say that it is worth the entire sum appropriated to the Department of Agriculture.

QUARANTINE DIVISION.

Stations securely inclosed, and provided with suitable sheds, yards, and conveniences for the care of stock, have been maintained for the ports of Boston, New York, and Baltimore. Cattle brought to these ports have been quarantined for a period of ninety days from the date of arrival at the station. Although the number of cattle imported during the year has not been large, the quarantining of them has been a necessary precaution to prevent the possible introduction of contagious diseases from foreign countries. The large expenditures which have been made by this country to exterminate such diseases from its borders have made this precaution of special importance to prevent the possibility of reinfection of the United States. In addition to the quarantine of cattle, a quarantine of fifteen days has been required upon all sheep and swine brought into the United States at these ports. The number of pure-bred sheep imported has been largely increased over that of other years, which makes this precaution of detention under veterinary inspection especially important and desirable.

When the demand for pure-bred animals is in excess of the supply, the tendency of those engaged in the business is to exercise less care to select only healthy animals and guard them against exposure to disease. It becomes purely a business enterprise with a manifest desire to curtail expense without especial regard to the ultimate loss which might result to buyers. The need for careful inspection under Government control is then more apparent. No important cases of disease have developed in either of the quarantine stations, and the vigilance of the officers of this Department has not been relinquished. The uniformly healthy condition of our flocks and herds in America makes it imperative that a strict oversight should be placed over all animals brought from foreign countries to prevent the introduction of such exotic maladies as would devastate an important industry, and lead to great loss.

DIVISION OF STATISTICS.

During the past year there has been an effort to give more prominence than usual to original investigation. The routine demands for results in crop-reporting and other lines are always exacting, and the means at hand for collecting special statistics and for compilation and preparation of special reports are limited. A more general and searching survey of the resources and condition of agriculture is necessary to

a proper understanding of its practical and political needs. Such investigation is progressing, and bulletins illustrating these conditions are in preparation. Some will present the status of rural industry in the older States, and others will show the resources and agricultural development of the States of the prairies and the plains.

Graphic illustration of statistics has met with much favor among industrial educators and students of rural economy. The issues of the past years, in this line, amount to 40,000 copies, the distribution having been mainly to farmers' institutes, agricultural and other colleges, and to libraries.

Special investigation is in progress in various lines in Europe for more exact data relative to production and prices of products with which America competes. It is realized by all thoughtful minds that while home consumption requires nine-tenths of our agricultural production, an active demand for any surplus relieves stagnation in the markets and advances prices. As this demand is limited and variable, its stimulation in certain lines is practicable and desirable. An agent is now in Europe laboring zealously against existing prejudice for the substitution of corn for rye, potatoes, and other food of the laboring masses. Much can be done towards enlarging both the quantity and variety of our exports of the products of agriculture, and the first step in this direction must be a more intimate knowledge by our own people of the condition and character of foreign markets. This information it devolves upon this division to provide. Much that is new in this direction is proposed for the statistical service of this Department. An increase in exports of only 10 per cent means an enlargement of the income of our farmers of over $60,000,000, and a steadying of prices of all that is consumed at home. A few thousands properly expended for such a purpose might add as many millions to the national agricultural income.

Anticipating a favorable result in the effort to extend the trade for our agricultural products in the South American Republics, and realizing that what our people needed in order to enable them to take advantage of such improved conditions of trade as might, through the efforts of this Government, be established with these countries—an anticipation which has, in regard to some of them, been already realized—there has been prepared from time to time in this division, and published in its regular monthly crop report bulletin, a series of articles upon the resources and agricultural conditions of leading countries of South America. As these reports go largely to the same circle of readers, I have directed that the several reviews of the countries of Central and South America referred to be republished in a bulletin for general distribution. This will no doubt be ready before the close of the year. The employment of special agents to further investigate this subject, the character of agricultural products demanded in these countries, the prices obtainable for them, the quality of goods demanded, and, in a general way, the opportunities that exist in this direction, is

much needed, and I trust it will be in my power to carry out such a plan.

Another feature of foreign agriculture which has commanded attention in the work of this division has been what might be called "the political economy of farming," and careful compilations have been made of the coöperative bank and loan systems of several countries, including Russia, France, Germany, Austria-Hungary, and others, in so far as they apply to the farming community. The results of these investigations have also appeared from time to time in the regular monthly crop reports of the division; but it is my intention that they also shall be reprinted in a single bulletin, in which I hope to be able to superadd some of the valuable suggestions available as the result of the deliberations of the International Congress held at The Hague last September. In these days there is no distance limitation to possible competition, and it is incumbent upon the Statistical Division of this Department to investigate the conditions of agriculture throughout the world, for there is no section of the civilized world which may not at some time and in regard to some product be found to be a competitor of the American farmer, nor in which at some time and for some product the American farmer may not find a possible market.

DIVISION OF CHEMISTRY.

In addition to the routine duties of the division, two main lines of investigation have been followed.

The first line relates to the methods of manufacture of sugar from beets, sugar cane, and sorghum. An experimental station for the production of beets of high saccharine richness has been established in Nebraska, and the results of the first year's work are eminently satisfactory. The beets have yielded over 20 tons of roots per acre, with a sucrose content of about 15 per cent, which is equal to the average content in sugar of the sugar beets of Europe. Scientific methods of culture have been followed, devoted particularly to the purpose of growing mother beets of high saccharine richness for the purpose of producing seed.

In Florida an experimental station has been established for the purpose of investigating the possibilities of the reclaimed muck lands of that State for the growth of sugar cane. The season's work at this station is not yet completed, and therefore no statement of the results can be given.

In Kansas two experimental stations have been conducted, one for the purpose of developing a higher grade of sorghum cane for sugar-making purposes, and the other for the purpose of illustrating the possibilities of the alcohol process for producing sorghum sugar. The work of both of these stations has been attended with great success. Over 150 pounds of sugar per ton of cane have been obtained by the alcohol

process from the first run of the cane through the mill, and it is estimated that at least 50 pounds can be added by the subsequent runs, thereby doubling the product as compared with the old process, and demonstrating that by the use of this process sorghum sugar can be made with the same ease that sugar is made from sugar cane. It is believed that the results of the work of the Chemical Division in this respect will be of such a nature as to encourage capital to investment in sorghum sugar making with the assurance of a profitable return on the money invested, provided the other features relating to geographical limitations, improved varieties, careful culture, and adequate manufacturing facilities, insisted on in my previous reports, be observed.

The second line relates to the continuation of the investigation into the adulteration of food. This work has been confined chiefly, during the past year, to studies of the composition of sugars, molasses, sirups, honeys, and confections; teas, coffees, and chocolates. Samples of these articles of consumption have been purchased in all parts of the United States and submitted to examination for the purpose of detecting the character and extent of the adulteration.

In regard to the sugars no adulteration has been discovered. The cheaper sugars of commerce are boiled in such a way as to incorporate with them a considerable quantity of molasses and water. Some of the low-grade yellow sugars which are sold have been found to contain only about 86 per cent of pure sugar. The presence of water and molasses in the sugar can not be regarded as an adulteration, inasmuch as these are natural constituents of sugar in the raw state. It is simply a question for the buyer to know whether he gets the same amount of saccharine matter by purchasing the low grade of sugar of this kind for a given sum as he would were he to purchase the high grade refined sugar at a higher price.

In regard to molasses and sirups and the liquid honey, however, the large majority of the samples on the market are adulterated with glucose made from maize or potatoes. This adulteration is not generally considered harmful, but so far as used is fraudulent; but another occurring in molasses is certainly deleterious, to wit, the bichloride of tin used in giving a luster to high-grade yellow sugar, which ultimately finds its way into the molasses. In tea the chief adulteration seems to be the admixture of foreign leaves and the refuse of the leaves which have been once exhausted.

The results of the examination of coffee were remarkable and startling. Not only has it been found that a large percentage of the ground coffees of commerce is adulterated with chicory and pea and bean flour and other harmless substances, but it was found that wholly artificial coffee beans have been introduced into the market, many samples of coffee bought on the open market consisting largely of these artificial beans. These beans are made of chicory, pea and bean flour, and caramel, and molded so as to resemble the natural coffee berry. These wholly artificial beans are sold to the trade at 4 cents a pound.

These investigations disclose the fact that in a large measure these fraudulent beans are imported, and I am firmly of the opinion that such importations as well as their manufacture and use in this country should be prohibited by appropriate and stringent legislation.

DIVISION OF ENTOMOLOGY.

Much interest has been occasioned and some alarm felt during the summer by widespread reports of unusual abundance of locusts or grasshoppers, particularly in the Western States. Reports from farmers have come from Michigan, Minnesota, North Dakota, South Dakota, Montana, Wyoming, Idaho, Kansas, Nebraska, Colorado, Texas, New Mexico, and California. In all of these States, except California, a repetition of the locust scourge of 1874 to 1876 was feared. In this emergency active measures were undertaken to arrive at a proper understanding of the true state of affairs. Four special agents qualified for the work were sent into the field, and all of the States mentioned were visited. In all except Minnesota and North Dakota the insects were found to be local species which had from various causes become exceptionally abundant. None of them are greatly to be feared, and all are nonmigratory, except in small degree. The visit of the agent was sufficient in most cases to allay fear for the future. Considerable damage, however, was done in parts of California by the devastating locust, and in North Dakota and Minnesota undoubted specimens of the Rocky Mountain locust (*Caloptenus spretus*) were found, indicating that this notorious insect had migrated in small swarms from its permanent breeding grounds, and justifying some apprehensions as to the prospects for next year.

Anticipating from the records of 1890 an exceptional demand for information on the subject, the Department published early in the spring, under serial number 25, Entomological Division, a bulletin on destructive locusts, summarizing the habits of the principal destructive species and giving at some length an account of the best remedies to be used, particularly against the Rocky Mountain species. The authorities, ably assisted by the farmers, have been carrying on a vigorous warfare on the lines suggested by the bulletin with excellent results, and their crops will, it is hoped, be saved from destruction next year unless the insect has been breeding in numbers across the line in Manitoba and British Columbia. We have the assurance of the Canadian authorities that, so far as they can find, no swarms have been observed in that part of the Dominion. The outlook for the coming season is therefore, on the whole, favorable.

The investigation of the bollworm of cotton mentioned in my last report has been continued through the present season. An agent has been stationed at Shreveport, La., conducting in the main experiments with bacterial and fungous diseases of other caterpillars, with the view

of endeavoring to procure a contagious germ which may be artificially transmitted to the bollworm. His efforts have as yet been rewarded with only partial success, but many facts of scientific value have been brought out. Another agent has been working in Arkansas on different insecticide mixtures for this insect, but the work of the season has been hampered from the fact that the bollworm in that locality has not been numerous.

The entomologist has for some time been endeavoring to introduce some of the European parasites of the Hessian fly. A supply of the Hessian fly infested by the commonest European parasite—*Semiotellus nigripes*—was secured. These were placed in the hands of several agents and correspondents of the Division of Entomology in sections of country infested by the Hessian fly, and directions were given as to the best methods of bringing about the acclimatization of the parasite. One of these experiments has resulted satisfactorily, and the parasite has become established in that vicinity. Practical results of great value are to be anticipated from these experiments. Another experiment in the importation of European parasites has resulted successfully. In 1883 the commonest European parasite of the cabbage worm was brought over in small numbers and established near Washington. A year ago a second lot was imported and placed in the hands of an agent of the division at Ames, Iowa, who reports that this parasite has become very abundant at Ames and has greatly reduced the numbers of the cabbage worms. The same parasite is now reported from a large extent of country.

Early in the summer the hop plant-louse was reported as exceptionally abundant in the hop-growing regions of New York State, and a repetition of the great damage of 1886 was feared. An emergency bulletin was prepared covering the life history of the insect and the best remedies to be used against it, and was distributed about the infested region. Largely, I believe, as a result of this prompt action on the part of the Department, hop-growers were enabled to fight the insect in the most approved manner, and the damage to the crop has been comparatively slight. The bulletin in question was also distributed in Wisconsin and in the hop-growing regions of Oregon and Washington, where the insect first made its appearance two years ago.

The State Board of Horticulture of California, having obtained an appropriation to permit it to make further efforts to secure parasites, by resolution placed the sum at my disposal, with a request to send Mr. Albert Koebele, an agent of the Division of Entomology, who had been so successful in securing the Vedalia ladybird, on another mission to Australia and New Zealand for the purpose of studying and importing into California other insects which might prove of benefit to the horticultural and agricultural interests of that section of our country. This I consented to do, his expenses to be paid by the board and his salary by this Department, with the understanding that he report to the Department. He sailed August 23, 1891.

The gypsy moth, a destructive insect imported from Europe, has invaded the State of Massachusetts, and threatens great injury to many forms of cultivated vegetation, particularly to fruit and shade trees. The Department has been consulted by the State Board of Agriculture, and the entomologist has twice visited the infested region during the season for mutual consideration of the best means for eradicating the pest.

The subject of bee culture has been a particular subject of investigation the present season. A station for experiments has been established in Ingham County, Mich., and a special agent has been appointed and stationed temporarily at Washington to take charge of the work in this direction.

Other investigations of less general importance, having, however, a strong bearing upon the farming interests of restricted localities, have been carried on. The stationary field agents of the division have been industriously at work in their different localities upon injurious insects, with the best of results.

DIVISION OF BOTANY.

The work of the division in the line of exploration and survey of the vegetable productions of the country has been extensive. In conjunction with the Division of Economic Ornithology an exploration of the Death Valley in southeastern California was undertaken, beginning about January 1. The object of this expedition was to obtain a complete knowledge of the animal and vegetable life of that desert region, including several mountain ranges which traverse the valley as well as those which form its boundaries, and to mark as completely as possible the limits of the life zones from the lowest to the highest points of the region. Two botanical collectors were constantly in the field for eight months, or until the field work was closed. The plants collected have been received at the office of the division, and are now being carefully and thoroughly investigated. The results of the work will be embodied in a bulletin, which it is believed will be of unusual interest and of great scientific value.

Botanical work has been continued in western Texas, New Mexico, and Arizona with special reference to the grasses and Cactaceæ of that region, with the purpose of supplying greatly needed information on some of the widely diffused and yet little known plants of this region of country.

Botanical investigations and collections have also been made in the Indian Territory, in Nebraska, in northern Wisconsin, and in Minnesota. The collections from these sources have been very satisfactory, have contributed much to our knowledge of the vegetation of those regions, and have added much to the value of the Herbarium. We have also had a botanist in southern Florida, who has investigated the vegetation

of the keys and coast, and has added much to our knowledge of that region.

The Herbarium work during the year has been much enlarged, many thousand specimens have been added to the permanent collection, many thousands have been distributed to the agricultural colleges, and exchanges have been made with many scientific societies, both domestic and foreign.

Several new botanical bulletins have been published, particularly No. 4, of Contributions from the National Herbarium, giving an account of a very interesting collection of Mexican plants; and No. 1 of the second volume, which is the first part of a Manual of the Flora of Texas, which is being prepared as a convenient reference book for botanists and residents of Texas and the adjoining region, a work which is much needed and is highly appreciated. The second part of the illustrated work, called "Grasses of the Southwest," is now in press, and when bound with the first part will make a valuable volume of illustrations of North American grasses.

The experimental grass and forage station which this division has in charge at Garden City, western Kansas, has now been in operation for three years. It was established for the purpose of testing grasses, forage plants, and grains which are best adapted to cultivation in the arid and semiarid districts, and of ascertaining what are the possibilities of agriculture under the conditions there existing. The experiments have been conducted on a large scale and with great care, and the results obtained this year are highly satisfactory, showing that certain varieties of grains, grasses, and forage plants have withstood the aridity of the climate and have produced crops which compare well with those of more eastern and moister regions. These experiments will be continued for a fuller confirmation. It seems to be proven that to secure a good stand of grasses for pasturage a longer time is required than in a moist climate, but that with proper varieties and proper management a good result may be obtained.

So general has been the desire to ascertain the possibilities of grass and forage growth without irrigation, that arrangements have been made with many of the experiment stations in other portions of the arid territory to conduct jointly with this Department a series of experiments in this line. New Mexico, Arizona, Utah, Wyoming, North and South Dakota, and Colorado are the points where these experiments have been instituted.

DIVISION OF ORNITHOLOGY AND MAMMALOGY.

During the past year the work of this division has been continued in the directions indicated in my last report, namely, (1) the collection and diffusion of information relating directly to the economic value of mammals and birds; and (2), researches relating to the geographic distribution of species, with special reference to the ascertainment of

the boundaries of the several life zones in the Western States and Territories. A report has been published comprising the results of a biological reconnoissance of Idaho, made in 1890.

The most important work of the year has been a biological survey of parts of southern California and Nevada, known as the Death Valley expedition, which was in charge of Dr. C. Hart Merriam and Mr. Theodore S. Palmer, the latter being in charge during Dr. Merriam's absence. This expedition was organized for the primary purpose of determining the boundaries of the natural life zones in southern Nevada and southern California, and studying the problems relating to the laws which govern the distribution of life. The northern boundary of the Lower Sonoran Zone was traced by Dr. Merriam in person completely across the southern part of the Great Basin from Owen Valley at the foot of the Sierra Nevada in California to the Santa Clara Valley at the foot of the Great Colorado Plateau in Utah. The determination of this line, never before attempted, is a matter of considerable satisfaction to the Department, inasmuch as it fixes the northern limit of successful raisin production and of profitable cultivation of several subtropical fruits.

The area surveyed includes the High Sierra as well as the arid deserts contiguous thereto, and consequently embraces parts of all the life zones known on the continent of North America from the Arctic-Alpine to the Lower Sonoran. The area surveyed comprises about 100,000 square miles situated between the parallels of 34° 30′ and 38° north latitude in southern California and Nevada and a small area in northwestern Arizona and southwestern Utah, thus including all of the torrid desert valleys and basin ranges between the Sierra Nevada and the Colorado Plateau.

Through the coöperation of the Weather Bureau (transferred to the Department of Agriculture July 1) a meteorological station was established in Death Valley in April, where continuous observations have been taken until the present time. A regular station is permanently located at Keeler, on Owen Lake, and another was established near timber line on the High Sierra, so that simultaneous observations have been taken at three distinct points in the area under investigation, thus bringing together a series of thermometric and barometric data which have never before been available in work of this character.

The members of the expedition are scientific experts comprising the best field naturalists in the country in their several special lines of work. By coöperation with the Botanical Division a competent botanist, Mr. F. V. Coville, and a botanical assistant accompanied the expedition and made large collections of the grasses and other plants of the region. By coöperation with the Entomological Division an experienced insect collector, Mr. Albert Koebele, joined the expedition in the Death Valley region early in April and remained a little more than a month.

Incidentally, large collections were made in various departments of natural history, and it is expected that the report of the work of the

expedition will be of more than ordinary scientific as well as practical interest.

In addition to the Death Valley expedition, field work has been conducted in parts of Texas, northern Idaho, and the State of Washington.

SECTION OF ECONOMIC RELATIONS.

The economic work of the division has been carried out mainly along the lines indicated last year. The illustrated bulletin on hawks and owls, described at length in my last report, still remains unpublished through lack of funds to pay for reproducing the colored plates. Meanwhile the text has been revised thoroughly, and considerable new matter has been added. It is believed that most of the material necessary for the completion of the bulletin on crows is at hand, special effort having been made the past spring and summer to procure the stomachs of old and young crows in corn-planting time and during the breeding season of the smaller birds. Only part of the material thus collected has been studied, but the examination of the rest will be completed at once, and the bulletin will be issued as soon thereafter as possible.

Some progress has been made on the other bulletins mentioned in last year's report, particularly on that relating to the crow blackbird. Several hundred stomachs of this species have been added to the collection, and the preliminary examination of most of them has been made.

The reference collection of seeds has been greatly enlarged and its utility correspondingly increased; and a series of slides for the microscope has been prepared showing fragments of the skins and other tissues of carefully identified seeds and fruits, and also fragments of worms, crustaceans, insects, and other invertebrates which are likely to be found in the stomachs of birds.

The routine work of the division is steadily increasing. The number of specimens received for identification is much larger than in previous years, the total number for 1891, including those collected by field parties of the division, exceeding 10,000.

DIVISION OF FORESTRY.

This division was principally designed to give information upon and to arouse and stimulate interest in forestry matters, hence its labors hitherto have, more than those of other divisions, been of a missionary character.

The wisdom of its institution and the timeliness of its warnings can no longer be doubted, showing as it has the inevitable consequences of an irrational treatment of our forest resources. It has become apparent that there is no such thing as "inexhaustible supplies" when increasing demands of an increasing nation are to be satisfied; it has become also apparent that thousands of acres of good agricultural soil

have annually become barren and waste, and are being washed away, merely through lack of attention to the forest cover and the unwise and improvident removal of the same. Persons in high authority and whose judgments command respect allege that the cause of excessive water conditions in some of our rivers is the denudation of their banks, and recommend as a principal remedy their reforestation. It is claimed that much of the loss by flood which we experience annually could be avoided by a proper attention to our forest cover.

The existence of a Government agency to promulgate sound forestry principles, while the Government itself has made no provisions to apply such principles to its own permanent timber lands, is an incongruity that suggests the desirability of further legislation. The power conferred upon the President by the law of March 3, 1891, to establish forest reservations must needs remain largely inoperative as far as maintenance of proper forest conditions is concerned, unless it be followed by the establishment of a proper administration based upon forestry principles. The establishment of permanent reservations of forest lands, needful for maintenance of proper water conditions placed under a rational management seems to be a proper forest policy for our immediate future.

Since it has been understood that not only questions of arboriculture and woodcraft, but all those relating to the utilization of the products of our forest, belong within the sphere of this division, since in fact the great lumber and wood-working industry of the country, ranking at least second in value of product, finds in the Forestry Division its first official representation, the demand upon it for information of the most varied kind has increased and makes an increase of its force and an extension of its investigations imperatively necessary, if it is successfully to satisfy the great interests which it is to subserve. A slight increase in the appropriation has enabled the division to enter upon a somewhat more extended line of original research.

The most noteworthy and far-reaching work of this kind inaugurated is the examination and testing of our more important timbers upon the most comprehensive and exhaustive plan ever undertaken in any country except Prussia, where simultaneously a similar line of investigations has been inaugurated. This work has elicited the highest commendation from engineers, bridge-builders, and others interested in large wooden structures.

The object of this work is not only to obtain a better knowledge of the properties and technical adaptation of our woods, but to furnish an estimate of the interrelation between quality and physical appearance and structure, and also between quality and conditions of growth. At the same time opportunity is afforded by the examination of an unusually large amount of material of known origin to establish the laws and rate of growth of the different species, a knowledge upon the basis of which alone forestry can be carried on profitably.

One of the special investigations flowing from this work now in progress is as to the effect of turpentine orcharding upon the quality of the pine, the results of which it is expected will clear away the prejudices existing against such timber and place a proper value upon thousands of square miles of so-called turpentine timber.

DIVISION OF VEGETABLE PATHOLOGY.

During the past year, as heretofore, the Division of Vegetable Pathology has devoted special attention to field work, having in view the prevention of plant diseases. At the urgent request of a large number of western New York nurserymen and fruit-growers, an assistant of the division was sent to Geneva early in the season, with instructions to remain on the ground and conduct such investigations as would throw light on the cause of a number of destructive plant maladies and the best means of combating them. Through the courtesy of the experiment station authorities at Geneva the assistant was given a room in the station building, where every facility was afforded for doing good work. The investigations for the most part have been confined to nursery stock in the vicinity of Geneva, although considerable attention has been given to diseases of fruit in other parts of the State. As an indication of the interest and confidence in the work of the division it may be stated that nearly three million trees of cherry, apple, quince, pear, and other fruits in the nursery have been treated for leaf blight and other diseases the past season in the vicinity of Geneva. Taking the country at large, no less than ten million nursery trees were treated the past season in accordance with directions issued by the division. In addition to the work on nursery stock, extensive experiments have been made in treating diseases of orchard fruits, such as apple and pear scab, pear-leaf blight, peach rot, cherry-leaf blight, etc. Through the investigations of the division several of these diseases can now be successfully controlled at comparatively little expense.

In the treatment of grape diseases, several new lines of work have been undertaken; the principal one was an attempt to cheapen the treatments without affecting their efficacy. It was shown, among other things, that the copper in the Bordeaux mixture could be reduced 90 per cent without apparently affecting its efficacy as a preventive of black rot and mildew of the grape. If the results of this experiment are substantiated by others made on a large scale and under varied conditions of climate, the cost of treating grapes for mildew and rot can be reduced from $14 to a little over $2 an acre. It is gratifying to announce that the efforts of the division to introduce cheaper machinery for the treatment of plant diseases is meeting with signal success. Suggestions have been made whereby suitable spraying machines have been manufactured in this country at far less cost than heretofore at home or abroad. Another drawback to a more general adoption of the treat-

ments suggested by the division has been the difficulty met with in getting the various preparations used put on the market in concentrated form. Suggestions have been made, which have been in a measure complied with, to firms to put upon the market the necessary ingredients for preparing, in small quantities, the various solutions, mixtures, etc., set forth in the publications of the Department.

The laboratory work during the year has been pushed forward with vigor. Investigations of this nature are always preliminary to practical work in the field. For the most part the work the past year has been confined to a further study of grape diseases, pear blight, peach yellows, the California vine disease, rot of sweet potato, and a bacterial disease of oats. The new lines taken up, and which as yet have not yielded sufficient results to warrant an attempt at practical experiments in the field, are investigations bearing on blight, foot rot, scab, and other diseases of the orange, rust of cereals, diseases of violets, carnations, and other greenhouse plants and several bacterial and fungous diseases of injurious insects.

Since my last report the work on the California vine disease has been continued. From the 1st of November, 1890, to the early part of May, 1891, the special agent in charge of this work was engaged in the preparation of a report on the subject. Since the completion of this report the agent has been engaged in laboratory and field investigations in various parts of California. The hope is strong that the virulence of the disease is abating, and the outlook in southern California is much more encouraging than at any time since the dread malady appeared.

At frequent intervals during the past three years urgent calls have come from Florida and elsewhere for information in regard to the diseases of citrus fruits. Practically nothing in the way of investigating the many serious maladies of this important group of plants has been undertaken in this country. In the early part of the year a special agent was sent to Florida with instructions to remain a month and collect such general information on the diseases of the orange and similar fruits as the limited time would permit. Later in the season a new disease, locally characterized as blight, wilt, or "go back," made its appearance to an alarming extent in several parts of Florida. Two special agents were detailed to visit the infested regions and gather as much information as possible on this and other diseases. Owing to the lack of funds the agents spent only a short time in the field, but it is believed that the information obtained will be of value when the time arrives for a thorough investigation of this subject, which will be when the means are forthcoming. The new disease has already caused thousands of dollars' damage in some of the finest groves in Florida, and there is no question that unless steps are taken to check it serious results will follow.

In the peach yellows investigation special attention has been given to a continuation of the work on fertilizer experiments and the com-

municability of the disease. As a result of three years' careful work, involving over 40 acres of orchard and the use of almost every conceivable kind of fertilizer, it may be said that in not a single instance has a case of yellows been prevented or cured by the use of fertilizers. This experiment was made to determine whether the cause of the disease was the lack of nutrition and immature growth. The question as to the communicability of the disease is no longer a matter of doubt, it having been proved conclusively that the malady may be communicated by budding. A disease called peach rosette, which closely resembles yellows, but which is even more virulent, has been studied in Georgia and elsewhere. Evidence seems to establish also the communicability of this disease.

In addition to the foregoing, exhaustive laboratory investigations on the disease in question have been under way. This, together with the other work, while not actually furnishing evidence as to the cause of yellows, is gradually narrowing the lines of research, making future investigations far more tangible.

OFFICE OF EXPERIMENT STATIONS.

The principal work of the Office of Experiment Stations under law is the preparation of publications relating to the work of the agricultural experiment stations. Nineteen documents, aggregating 1,335 pages, have been issued during the past year, chief among which is the second volume of the Experiment Station Record, consisting of 12 numbers, with a classified table of contents and a detailed index. This volume of the Record contains abstracts of 329 bulletins and 42 annual reports of the stations and 36 publications of this Department, aggregating 14,781 pages. It contains abstracts of sufficient length to show the object and plan of the investigations reported, the main facts necessary to an understanding of the way in which researches were carried on, and the results reached. It also contains suggestions of lines and methods of inquiry for our stations, and statistics and other information regarding experiment stations in this and other countries.

To meet the urgent demand, referred to in my last report, for information regarding the results of agricultural inquiry in Europe, the office has added to the Record reports of European investigations. It has been necessary, however, to confine the work to subjects of wide interest or immediate importance to our station workers.

The literature relating to investigations in agricultural science is so extensive that a general card index, prepared in the best manner and kept up to date, has become a necessity for investigators and students. The Department has been forced, therefore, to enter upon the preparation of such an index for itself and the experiment stations, and the first installment of cards has been issued to the stations and agricultural colleges. It is believed that such an instrument will be of very great

service, not only in giving information as to what has been done and thus preventing our stations from going over ground already covered, but also in suggesting new lines and methods of inquiry, and in raising the general level of our experiment station work.

Representatives of the office have visited twenty-three stations with a view to observing the progress and needs of their work and for personal conference regarding the interests of their common work.

The work of this division of the Department had so increased both in amount and scope that it became absolutely essential that the director should devote his entire time and energy to official duties. Prof. W. O. Atwater, realizing this necessity and not being able to comply with it, has resigned the directorship of the office. His services will, however, be retained, and the fruit of his wide experience and study with regard to European investigations in agricultural science will be made available by contributions to the Record in certain special lines.

Under the new organization of the office Mr. A. W. Harris, formerly assistant director, becomes director, and Mr. A. C. True, formerly first assistant editor, becomes assistant director. The editorial and clerical force of the office has been somewhat enlarged.

Agricultural experiment stations are now in operation in all the States and Territories except Montana and Idaho. During the year new stations have been established in Wyoming, Oklahoma, and Washington. Of the fifty-five stations in the United States, fifty in forty-three States and Territories receive their support wholly or in part from the United States Treasury. The stations employ 450 persons in the work of administration and inquiry. The mailing lists of the stations include about 350,000 names. The results and processes of their experiments are described not only in the station bulletins and reports, but also in thousands of newspapers and other periodicals. During the past year there have been many evidences of public approval of the stations and their work, as indicated by acts of State legislatures in their behalf and money grants by local communities, agricultural associations, and private individuals.

Among the investigations of wide interest which have engaged the attention of the stations during the past year may be mentioned those relating to the feeding of milch cows, pigs, and beef cattle; experiments in the culture and improvement and varieties of corn, wheat, oats, sugar cane, potatoes, and tomatoes; investigations of the nature of the various kinds of smut in cereals, and the testing of means proposed for their prevention; the devising of simple and practical methods for the testing of milk at creameries and at private dairies. In one State a thorough and systematic study of the soils by field surveys and laboratory tests is being vigorously prosecuted. In twenty-five States stations are performing, either wholly or in part, the chemical and other work connected with the inspection of fertilizers. In coöperation with this Department a number of stations are conducting experiments with ref-

erence to the introduction of the sugar-beet industry. The horticulturalists of the stations have extended the lines of their work, and in addition to the testing of varieties have carried on important investigations in the improvement of fruits and vegetables by cross fertilization and selection.

In general, it may be said that the past year has brought many evidences that the individual stations are finding the lines in which they can best work, and are entering upon systematic courses of experimenting, which should ultimately bring results of great and lasting value to the agriculture of the country.

DIVISION OF POMOLOGY.

The fruit crop has been unusually large. All the orchard fruits have borne abundantly in almost every section; the plum crop is reported as being the largest ever known; and small fruits and grapes have been very prolific. The work of the division has been essentially along the lines indicated in my former report. The text and the plates of the wild grape monograph are completed and ready for the printer; but the expense of publishing the plates is so great that I am not yet justified in ordering their publication from the regular printing fund. The monograph is really of such value that it is hoped that the means may be provided for this publication.

A bulletin on the nuts of America, with illustrations, is now in press. Some new fruits have been imported and are being tested; among them, persimmons from Japan, reputed to be hardy enough for the Northern States; and some date palms from Arabia for the semitropical regions. Some new native fruits have been distributed, and more could be done in this line if the means were afforded.

One of the problems in pomological circles is how to secure a class of apples for the northwestern States that can endure their northern climate. It is claimed that, while much good has been accomplished by cultivating the Russian apples, it is found that they do not prove as successful as was hoped. Fruit-growers, therefore, have anticipated a possibility of securing a stock sufficiently hardy for the northern climate, and of good quality, from the propagation of wild fruit and native seedlings and by experimenting therewith, selecting and sifting continually the best, until really valuable ones may be obtained. It is claimed that the most valuable apples that they have to-day in the Northwest are not Russians, but have been developed on their own soil in the way above indicated. For this reason the Pomological Division is giving such consideration to this subject as its limited means will allow.

The work of the division continues in completing the record of the distribution of the various fruits and their varieties, so that ultimately an exhaustive monograph on that subject may be published. The bulletin on small fruits is well under way.

DIVISION OF MICROSCOPY.

During the current year this division has been engaged principally on microscopical investigations in relation to food adulteration, including the examination of various lard compounds, butterines, condiments, and commercial oils, and in microscopical examinations of samples of milk, cream, butter, and water received from various parts of the country.

The division has, in addition, continued the collection, classification, description, and illustration of edible and poisonous mushrooms of the United States, and has made examinations of the structure, and experiments as to the tensile strength, of numerous textile fibers. It has also made investigation and comparison of the different classes, grades, and qualities of wool, and the microscopist has been frequently called upon to testify in the United States courts, in cases when these grades and qualities have a bearing upon the duty imposed.

The Department has just received from the State Department samples of wool from Chian, Palestine, and Asia Minor, an important addition to its collection, which will be used in future comparative examinations.

The Department has an increasing demand from all parts of the United States for additional information and for copies of the illustrations and recent reports made by this division upon edible and poisonous mushrooms. The publication of these reports has stimulated a more lively appreciation of the value of an esculent which is used on so large a scale in European countries and which offers to the farmer an important and remunerative field of culture.

ARTESIAN WELLS, UNDERFLOW, AND IRRIGATION.

The Fifty-first Congress appropriated in all $70,000 for investigations into artesian and underflow waters, the sources thereof, and their availability for irrigation within the region known as the Great Plains, and for an "inquiry into the best methods of cultivating the soil by irrigation." These appropriations were made under three different provisions, the first by act of April 4, 1890, appropriating $20,000, the second by act of September 30, 1890, appropriating $40,000, and the third by act of March 3, 1891, appropriating $10,000. The first act required a report immediately after July 1, 1890, which report was duly made. The second required that the report be fully completed before July 1, 1891. The time for the completion of the final report under the first two appropriations was extended by act of March 3, 1891, to January 1, 1892.

The staff of the artesian and underflow investigation was again in the field very soon after the approval of the act of September 30, 1890. The engineers and geologists worked faithfully throughout the autumn and winter months in the southwestern and western portions of the territory under investigation. The chief engineer completed a progress report,

accompanied by maps and profiles of the territory embraced by and lying between the valleys of the Arkansas and North Platte rivers. These profiles illustrate the depth and location of the drainage or underground waters found within this section of the Great Plains. They show also the possibility of utilizing a large water supply now lost in the sand and gravel stratum of the two river valleys named. The reports already printed strongly confirm the claim now made that the loss by seepage within the porous strata of these river valleys is large enough, if it were restored to their channels, to make streams doubling in volume the present rivers. The geologist sent a brief progress report showing the existence of what are termed rivers of the mid-plains, *i. e.*, streams fed and maintained by the regional precipitation or rainfall, which streams if they could be diverted at their sources or recovered from the area in which they now sink, and be thereafter stored and diverted to the plains for the purposes of irrigation, would make certain the reclamation of a very large proportion of the region. The partial reports prepared by the chief engineer and the chief geologist were printed early in the present year with a progress report on irrigation which the special agent in charge had prepared under my direction in the Office of Irrigation Inquiry.

The field work was continued in the southwest during a large portion of the winter, and in portions of Colorado and Nebraska, till long after the first snows had fallen. As early as possible in the spring the staff of the artesian and underflow investigations was transferred to the northern portion of the region, embracing the two Dakotas, western and northern Nebraska, and a portion of eastern Wyoming and Montana. The southwestern assistant geologist continued at work during the winter and spring and until early summer, when he submitted his report embracing the several artesian basins in western and southwestern Texas. The whole inquiry throws a flood of light on the existence and extent of the two largest artesian basins known to the world, one being that of the Dakotas or James River Valley, and the other that of central Texas from Fort Worth to the south and west. Since the beginning of the field work in the investigation ordered by Congress, and as a result of the limited publication of the reports thereof, great encouragement has been given to the farming population west of the ninety-seventh meridian of longitude. The activity displayed in the search of artesian waters has resulted in the successful drilling of several hundred additional wells during the past year. No diminution of flow has yet been reported. It has added also to the hopefulness of the people, encouraging them in more or less successful efforts to utilize underground and other water supplies. At the earliest practicable moment the field staff was reduced in numbers, and the field work entirely suspended October 1, since which time the chief engineer and geologist have devoted themselves to the preparation of their reports.

The inquiry thus conducted necessarily embraced an examination of

several northern sections in which artesian waters were not expected to be found. These investigations include the Red River basin in the northern and eastern part of North Dakota, the Turtle Mountain and Devil Lake drainage basin, portions of the Upper Missouri and Milk River valleys, and engineer reconnoissance into the practicability of utilizing for the purpose of an irrigation supply certain lakes lying near the British-American frontier, and the report thereon will be sent to Congress with appropriate maps, plans, and illustrations.

The progress report prepared by the special agent in charge since the date of my last annual report makes a volume of over 300 pages. Besides the special agent's report proper, it contains a report on irrigation in the States of Montana and Idaho, with portions of Washington and Oregon, prepared by a special agent sent from this Department. It also contains papers on irrigation in Colorado and Nevada; others on the "Imbibition of rocks;" the "Culture of the raisin grape by irrigation;" "Irrigation in Australia," prepared by the special agent in charge; formulas for the measurement of water, and other matters useful to those interested in irrigation. A constant demand for the report of the Artesian wells investigation and for that of the Irrigation inquiry has been made on this Department. As Congress made no provision for their publication in any number, I have been unable to meet these requests. I have the assurance that the final report required by act of March 3, 1891, will be completed by January 1, 1892.

In completing the work of the artesian and underflow investigation, as assigned to this Department by Congress, the utmost effort has been made to make it as exhaustive as was consistent with the comprehensive duty imposed upon me. The work has been so well done, as I hope, that, from the standpoint of objective or surface inquiry, but very little of economic value can be added. Other work would necessarily be ot an experimental character, embracing to some extent constructive processes not authorized by the present inquiry, and which I do not recommend to be undertaken by the National Government.

FIBER INVESTIGATIONS.

Fiber investigation during the past year has been confined chiefly to the flax interest in the Northwestern States, Minnesota being the center of cultivation, and to sisal-hemp culture in Florida.

Early in the year the Department imported from Europe three varieties of flaxseed for experimental culture, as follows: Pure Riga, White Blossom Dutch, and Belgian (Riga seed grown one year in Belgian soil). These were distributed to a very carefully selected list of names made up of flax farmers, directors of agricultural experiment stations in possible flax-growing States, and flax manufacturers. It is too early to give the results, but the samples of straw already submitted indicate that a good quality of Russian and Belgian flax may be grown and may come to perfect maturity over a large extent of our country.

Capital has been attracted to the industry, and several new manufacturing enterprises have been established. Altogether the outlook for the industry is most encouraging. Its greatest need, however, is the establishment of scutching mills by factors or buyers who will purchase the crop from the farmer when matured, harvesting it, and retting and scutching it under one supervision, in each community, and selling the fiber directly to the linen mills. Such a division of labor is essential to the success of the industry.

The flax products (raw fiber and manufactured) imported into the United States in a single year amount to at least $15,000,000, the larger proportion of which can be produced at home with the reëstablishment of the flax industry.

Sisal hemp is now growing in many portions of southern Florida, where its cultivation long ago passed the experimental stage. A fiber survey of the Florida Peninsula made last spring by the agent of this Department found the sisal-hemp plant growing most luxuriantly in a state of nature from Jupiter Inlet on the east coast down to Cape Florida, on many of the keys, and along the west coast as far north as Charlotte Harbor. On the keys plants were found with leaves from 5 to 6 feet in length and weighing 1½ to 2 pounds, and the fiber is of superb quality. The imports of sisal hemp from Yucatan into the United States in a single year amount to $5,000,000.

The interest in ramie still continues, but little can be accomplished, however, until the decorticator question is settled. The Department hopes to conduct at New Orleans during the coming year a trial of American machines for extracting the fiber, for which purpose a large quantity of ramie will be especially grown. There are already eight machines which would come into such a competition, besides several processes for extracting the fiber.

DIVISION OF GARDENS AND GROUNDS.

The distribution of plants from the division of gardens and grounds during the past year aggregated over 117,000 specimens, consisting of various hardy and semitropical species, special regard having been paid to their adaptation to various localities. On this special point there are many erroneous opinions entertained by applicants, both in regard to the climatic conditions indispensable for the healthy growth of plants, and to the value of the products from a commercial standpoint. It is almost a daily occurrence to receive requests from the warmest portions of the Southern States for strictly tropical vegetation, although the area where these plants can have even a semblance of success is very limited and of doubtful permanency at the best.

Correspondents in making requests for plants of such tropical species as coffee, nutmeg, cinnamon, cloves, tamarind, etc., will indicate their faith as to climate by stating that they have no frosts, although the

thermometer will at times drop down to 32° F., thus intimating the conviction that a tropical climate is shown merely by absence of freezing, whereas a tropical climate is one where the thermometer rarely shows lower than 70° F. Again, even with a suitable and favorable climate many of the staple products could not be raised as a profitable enterprise. Cinchona, for instance, is now grown to such an extent in the East Indies that the price of the article is so low that West India plantations are being abandoned on that account. The coffee plant and the tea plant, the latter especially, can be grown over a large territory in the United States, but only as a domestic product. Coffee has but a limited area in southern Florida, but the cost of picking and preparation for market would, as in the case of tea, leave no margin of profit when placed in the market to compete with the products of other countries.

While, therefore, the Department makes limited distributions of many semitropical plants, care is taken to advise against extended planting, or extended investments, until tests have proved the practicability of success.

The catalogue of economic plants in the collection of the Department, which I directed to be prepared for publication, was duly issued. There has also been issued from this division a bulletin entitled Papers on Horticultural and Kindred Subjects, which, although issued only a few months since, has been so widely called for as to make the propriety of publishing a second edition a subject for present consideration.

DIVISION OF RECORDS AND EDITING.

The wisdom of establishing the Division of Records and Editing becomes more and more apparent as the number of publications which are issued from the Department increases, and these are extended so as to cover a wider variety of subjects. The division is not only able to accomplish such editorial work as is necessary with reference to the bulletins prepared in the various divisions, and to exercise a general supervision over the publishing interests of the Department, but also to promote in a marked degree the advantageous and economical use of the printing fund.

For the first time I am able to express satisfaction with the extent of the appropriation made for the printing of this Department, which will render unnecessary the frequent delay in the publication of important bulletins entailed in previous years by the exhaustion of the fund, and the necessity of procuring a deficiency appropriation in order to enable them to be published at all. The Department is obliged to depend eminently upon its printed matter in order to reach the farmers in the country, and the character of our work, closely relating as it does to the several seasons of the year and their varying conditions, has always made delay in the publication of important documents a matter of grave

inconvenience, and it is not infrequently of serious loss to the farmers of the country. This year, I am happy to say, such need not occur.

The preparation of advanced notices of forthcoming bulletins for the use of the press, which was inaugurated soon after the organization of the division, has been continued in response to a very general expression of appreciation of this feature of the work, and because it is found to insure the advantageous results of prompt distribution of our publications.

DOCUMENT AND FOLDING ROOM.

The work of the Document and Folding Room, though not materially changing from year to year except as it increases with the enlargement of the number of publications of the Department, has been greatly facilitated by the transfer of the division to rooms much better adapted to its work than those it formerly occupied. Applicants whose names are upon our mailing lists to receive particular publications are now able to be supplied with these immediately after their receipt from the Public Printer. Prompt and suitable distribution of printed information, furthermore, has been promoted in a marked degree by the notices issued to the agricultural press by the Division of Records and Editing in advance of the actual appearance of publications.

SEED DIVISION.

The amount appropriated by Congress for this division has been expended to the best advantage in accordance with the intentions of Congress in relation thereto.

RAINFALL EXPERIMENTS.

At the first session of the Fifty-first Congress the sum of $2,000 was added to the appropriation for the Division of Forestry of this Department for the purpose of conducting experiments to ascertain the feasibility of producing rain by means of explosions. At the second session of the same Congress a further appropriation of $7,000 was made in the same form and for the same object. The Division of Forestry having no special facilities for the conduct upon a sufficiently extensive scale of such experiments, I concluded to place them in charge of a special agent selected from outside the Department service. Due preparation having been made, the experiments were conducted on an extensive scale during the past season in Texas. I have every reason to believe that, so far as the production of explosions is concerned, these experiments were eminently successful. As regards the object thereof, namely, the production of rain, I have no data yet at hand which would justify me in expressing any conclusions on the subject.

WEATHER BUREAU.

Immediately upon your appointment, July 1, of Prof. Mark W. Harrington, of Michigan, as Chief of the Weather Bureau under the Department of Agriculture, a consultation was held with that gentleman with a view to the efficient reorganization of the Bureau, to carry out the expressed intention of Congress to especially develop its work in the interest of agriculture. The working force of the Bureau, including the civilians and three commissioned officers of the Army, was transferred to the Department of Agriculture on that day, and all the regular employés of the Bureau under the Signal Service were retained. The office force at headquarters was reorganized into three principal divisions, namely, the Executive Division, Records Division, and Weather Crop Bulletin and State Weather Service Division, other branches of the work being conducted substantially under the same organization as existed prior to the transfer. The observing force outside of Washington was reorganized by the appointment of local forecast officials provided for in the appropriation bill, the appointee in every case being selected from the most experienced and competent observers of the service.

The extent of territory assigned to them has been in many cases extended to cover a whole State, or the part of a State nearest the station, and the restriction of forecasts to twenty-four hours was removed to the extent of allowing them, especially in harvest season, to predict the weather for more than one day in advance, whenever the meteorological conditions were so pronounced as to make forecasts for a longer period reasonably certain of verification. They were also instructed to study and endeavor to meet the various wants with reference to meteorological information of the several classes of the communities in which they are located, and to seek and employ every means of speedily reaching farmers with their forecasts. Means were adopted to secure much needed improvement in the weather maps issued at the principal stations, an improvement which is already quite marked. The issue of maps has been authorized at Albany and Oswego, N. Y.; at Charlotte, N. C.; at Charleston, S. C.; at Marquette, Mich.; and at Parkersburg, W. Va.; stations not heretofore issuing them, and the edition of maps at all stations has been very largely increased.

Since July 1 a number of stations at military posts have been discontinued, and many new ones established at the nearest city or town. There are still a few stations at military posts, the transfer of which to more central locations is being considered and arranged. The station at Fort Grant, Ariz., has been transferred to the agricultural college at Tucson, and still another transfer to an agricultural station is under consideration. Arrangements have been made by which the reports from special cotton-region stations, heretofore sent only to Weather Bureau centers, are transmitted also to the several State weather serv-

ice headquarters for incorporation in the monthly publications, weather crop bulletins, etc., issued by them. At the urgent request of those interested in cotton, arrangements have been made to include in these reports telegraphic information of the first killing frost at every cotton-region station. It is also designed to establish ten stations of observation in the sugar region, from which reports of temperature, rainfall, and frost will be telegraphed to a designated center daily, for publication and dissemination throughout the sugar belt.

An exhibit was made at the New York and New England Fair held at Albany in August, showing the working of a Weather Bureau station, including the instruments used, the issue of the weather maps, etc. The results of this exhibit were most gratifying, and will justify other exhibits of the same character on similar occasions, so as to give the people attending these fairs more intimate acquaintance with the working and objects of the Bureau. New weather services have been organized in Arizona, California, Florida, New Mexico, North Dakota, Oklahoma, Utah, Virginia, Washington, West Virginia, and Wyoming, making the number of State services in operation September 30 thirty-nine, and a complete local service will be organized at an early date in Georgia to meet the demands of the cotton-growers in that State. More than one hundred new voluntary meteorological stations have been established and equipped with instruments at the expense of the Bureau since July 1, and nearly as many more where the instruments were furnished at private expense.

The most practical work of the State services is the issue of the weekly weather crop bulletins, sources of reliable information for all interested in agriculture, following up the season weekly, so that an excellent estimate can be made at any time relative to the crops of any county, State, or the country at large. This branch of the service has been highly complimented. On June 30, 1891, there were 630 weather-signal display stations in operation to which the forecasts were telegraphed; 90 stations to which cold-wave warnings were telegraphed; 61 frost warning, and 6 rain warning, the latter in California. September 30 the number of weather-signal display stations in operation was 1,200, an increase of nearly 100 per cent in three months. As an instance of the value of frost warnings, I will quote a single instance by which, as the result oi a warning of a killing frost in Wisconsin on August 24, over one-third of the cranberry crop, representing $125,000, was saved through flooding. Frost warnings in Minnesota and the Dakotas in August enabled farmers to prevent much damage to their crops by the use of smudges, causing a dense smoke. In Kentucky nearly 150 frost-warning stations have been established and are now in operation for the protection of the tobacco interest.

The number of voluntary observers throughout the country has been greatly increased since the transfer of the Bureau to this Department, the percentage of increase in July and August being greater than at any

time during the year ending June 30, 1891. There are now about 2,200 voluntary observers in the United States, being an increase of about 400 for the past three months, and steps are now being taken to cover every section of each State or Territory with voluntary stations of observation, so as to leave no section without stations from 20 to 30 miles apart. To accomplish this it will be necessary that public-spirited towns or individuals purchase the instruments and shelter at a cost of about $20 for each set. There are but 150 sets of self-registering thermometers on hand for issue, and already nearly double that number of places have been located from which observations will be desirable.

Thus far the present year 258 thermometers and 93 rain gauges have been issued to voluntary observers, as against 157 thermometers and 52 rain gauges during the corresponding period of last year. The completion of an index of meteorological observations in the United States last year will be followed by the completion, at the earliest practicable date, of a similar working index for each of the grand political divisions of the world outside of the United States. The other divisions of the work, such as the service on the seaboard and Great Lakes, the river and flood service, etc., which were already in force, have been continued and enlarged, but I confine myself in this report to special mention of those features which relate especially to the development of lines of work designed especially for the benefit of agriculture.

At the recent conference of representatives of the weather bureaus of different countries in Munich, at which, as already stated, we were represented by the Chief of the Bureau and Prof. Abbe, a permanent international meteorological committee was appointed to superintend the execution of resolutions adopted by the congress and to provide for the convening of a similar congress at a future date. The fact that the Chief of the Weather Bureau was made not only vice-president of the conference, but also a member of this permanent committee, will indicate the appreciation in which our service is held by foreign meteorologists.

I have already referred to the initiation of measures for the future extension and development of the Weather Bureau in coöperation with the agricultural colleges and stations.

In concluding the review of the work done under the several divisions of this Department since the date of my last annual report, it gives me pleasure to state, and I say this advisedly, that each one of more than a dozen divisions whose work I have reviewed has returned in actual value to the country during the past year far more than the entire annual appropriation accorded to this Department.

When I assumed control of this Department I found most of these divisions already in existence and engaged largely on their present lines of work. Having satisfied myself as to the character and value of this work, I was content to let them continue as originally organized, encouraging them in every way in my power toward the achievement of

practical results, and on the line of cordial coöperation in all useful work. My personal attention was especially devoted to a general enlargement of the scope of work of the Department in the interest of practical agriculture, and especially to three principal objects: First, the extension of the market for the disposal of the surplus of our great staple crops, including the cereals, and especially our vast animal products; second, the enlargement of our productive capacity, so as to achieve the gradual substitution of home-grown for imported products; and third, the bringing of the Department into such close relations with the farmers of the country as would make them acquainted with our work and inspire them with confidence in our ability to serve them, as well as to impress more forcibly upon the responsible officers of the Department themselves the wants and conditions of the tiller of the soil. This report will not have accomplished its purpose fully unless it serves to satisfy you that these objects have already been measurably attained, and that, by steadily keeping them in view and extending and developing the means already adopted toward their accomplishment, we may reasonably entertain the hope of placing this Department upon a plane of usefulness commensurate with the fondest anticipations of all those who labored so long and so earnestly to raise the Department to its present official dignity, and to extend its opportunities for valuable work.

The time seems opportune for me to make some suggestions as to the best means of maintaining to the fullest extent the usefulness of the Department, and of still further developing its opportunities for the future. It is rarely given to any single man to superintend the completion of a great work which it has required a wide and mature experience to successfully plan, but the wise builder knows well that without a well-determined plan the building, when completed, will surely be found deficient in some respects. What this Department must eventually be in order to fully answer the expectations in which the farmers of the country have a right to indulge, and for which the National Government must make itself responsible, is the consideration which now deeply concerns me. The first thing to be done in considering this subject is to define the obvious functions of the Department so as, on the one hand, to fully meet all just expectations, and, on the other, to avoid any infringement on the sphere of work properly belonging to and undertaken by other legitimate agencies.

Primarily the work of the United States Department of Agriculture may be, I think, briefly summarized under two heads: First, scientifically, the collection and distribution of all information of practical value to the farmer in the culture of the soil; second, administratively, the control of all matters relating to agriculture coming under the head of interstate or foreign trade. The first involves the acquisition of information by special and intelligent observation and study of all known facts having a bearing upon the culture of the soil and the disposal of

the crops, and to this end we must be prepared to employ the highest order of expert talent, both practical and scientific. This first proposition also involves a careful scrutiny of all natural phenomena affecting agriculture, and continued research into the principles which underlie them, necessitating the very highest order of scientific investigation, both by experiments in the laboratory and experiments in the field. My second proposition involves the conferring upon the Secretary of Agriculture of the fullest powers necessary for the supervision and control of all interstate or foreign commerce in agricultural products and of fraudulent and other substitutes therefor, for the investigation of all animal diseases, and for the control of the movement of all animals which may be affected by communicable diseases, and even within certain limits for an adequate supervision of the trade in agricultural products in all foreign markets.

As the immediate result of an acceptance of this definition of the scope of the work devolving upon the Department, it is evident that our present facilities will need to be greatly enlarged. It may be objected, therefore, by those whose idea of good government never goes beyond the one idea of economy, or by those—of whom there are not a few—who, though willing to afford to the Government all the means necessary for the efficient transaction of its business, utterly fail to appreciate or to estimate the full importance of the work of a department exclusively devoted to the field of agriculture, that a complete equipment of this Department on the lines which I have indicated would involve too great an expenditure. To such I would reply by calling their attention to the fact that in another twenty years the population of this country will exceed 100,000,000 persons, of which number more than 30,000,000 will be actually engaged in gainful occupations, and that probably 40 per cent of these will be directly engaged in agricultural pursuits, and that upon their efforts not less than 40,000,000 of people will be directly dependent for a living, while the whole population indirectly will depend for its well-being and prosperity upon the success which will attend the efforts of those devoted to agriculture.

When that day comes, and the increase of land values and enlarged demands of increased population and of a greatly increased foreign trade shall have necessitated the development by artificial means of vast areas now uncultivated, the efforts of this Department on such lines as I have laid down will have increased the value of our annual agricultural products from between $3,000,000,000 and $4,000,000,000 to at least twice that enormous sum. In the face of such stupendous figures, which it needs no prophetic vision to clearly see, I submit that the largest sum necessary for the efficient carrying on of the work I have indicated will be comparatively insignificant.

Very respectfully, your obedient servant,

J. M. RUSK,
Secretary.

SPECIAL REPORT OF THE ASSISTANT SECRETARY.

SIR: I have the honor to submit the following article, which, in accordance with your request, has been prepared for insertion in your Annual Report, upon the coöperation of the Department of Agriculture with the educational forces in the United States relating to agriculture.

Very respectfully yours,

EDWIN WILLITS,
Assistant Secretary.

Hon. J. M. RUSK,
Secretary.

COÖPERATION OF THE DEPARTMENT OF AGRICULTURE WITH THE EDUCATIONAL FORCES IN THE UNITED STATES RELATING TO AGRICULTURE.

Agriculture is and probably always will be the largest single industry in the United States. This being so, it is natural to suppose that the forces in its promotion lead those of any other industry, and such is the case. They take almost every form and direction, but in no form or direction do they show this prominence in a greater degree than in what may be termed the educational; that is, in the effort to instruct and increase the intelligence of its workers in the capacities, operations, contingencies, and scope of the industry. In the first place we will briefly consider

THE GENERAL FIELD.

This general survey will naturally divide itself into four divisions: (1) Those forces that are in whole or in part fostered by the National Government; (2) those sustained in whole or in part by the several States, and localities; (3) those organizations of a voluntary character; and (4) the press and the literature specially devoted to agricultural subjects. In many cases the lines of separation are not clearly defined and the divisions in some degree overlap, but the main divisions are subject to this classification, and will without much forcing comprehend all we propose to discuss in this article.

FORCES FOSTERED WHOLLY OR IN PART BY THE GENERAL GOVERNMENT.

These forces are again to be subdivided into three: (*a*) The Department of Agriculture; (*b*) the Agricultural Colleges; and (*c*) the Experiment Stations. Before proceeding to discuss the matter further it may be well to define the scope to be included in the term "educational." Every investigation that has for its purpose a better or more economical operation; a better or more perfect understanding of the capacities of soil or climate; a more thorough knowledge of the character and qualities of food, both for plants and animals, and its best adaptation to nutrition; more practical information as to the nature and character of diseases incident to vegetable and animal life and how to prevent or cure them, and as to noxious insects and how to destroy them; a fuller comprehension of the law of supply and demand, with information as to their ratio up to date; a more extended trial of the adaptability to our soil and climate of new and improved varieties of seeds and plants and animals from foreign shores or from different localities in our own vast domain with its many conditions—in short, every study, investigation, or experiment that has for its purpose "the how, the what, and the why" of agriculture is, in its essence and in its outcome, in its germ and its fruitage, educational. We propose, then, to follow broad lines in our classification and discussion.

The Department of Agriculture.—In view of the foregoing definition, this Department is the most momentous single educational force in the United States. Referring to my contribution to the Annual Report of 1890 on "The Scientific Work of this Department in its relation to Practical Agriculture," to those who may desire details, we may be pardoned for a brief summary of the article in order to illustrate the proposition or statement. Its publications include the Annual Report, of 600 pages, of which there were distributed 400,000 copies; special reports like that recently issued on the "Diseases of the Horse," of which there were published 140,000 copies; three regular monthly publications, Insect Life, Experiment Station Record, and the Statistical Report, and one quarterly, The Journal of Mycology; bulletins on the sugar beet, on sorghum and sugar cane, and experiments in the manufacture of sugar; other bulletins from the Divisions of Chemistry, Entomology, Botany, Forestry, Pomology, Horticulture, Microscopy, Ornithology and Mammalogy, and Vegetable Pathology, and from the Office of Experiment Stations; and the reports of the Weather Bureau and the Bureau of Animal Industry—all with editions ranging from 3,000 to 25,000 and from 25,000 to 150,000 copies. These reports and bulletins, supplemented by circulars on many topics, cover almost every subject included in agricultural study, and are based upon thorough and profound investigations and application by a corps of zealous, practical scientists, whose reputation is high in the scientific world and in the domain of practical agriculture. Almost without an exception the editions, large

as some of them are, fail to reach the demand. The simple statement of these facts would seem to substantiate the proposition that this Department is the most momentous single educational force in the United States—it may be justly said, in the world. There is nothing equal to it or like it in any other country.

For these publications Congress appropriates, for the current year, nearly $400,000; and for the work, $2,320,153, including $879,753 for the Weather Bureau, transferred to this Department July 1, 1891.

The Agricultural Colleges.—Next to this Department stand these institutions, for, though separate, they are practically a unit, a system, a single force, supported in whole or in part by the National Government. In every State and Territory of the United States, except Montana and Idaho (excluding Alaska and the Indian country), there is such a college or an agricultural department in an existing institution which is the beneficiary of the Government—forty-three in all. In eleven of the States there are two, making in the aggregate fifty-four institutions projected on the same plan, and constituting, as said before, practically a single educational force. In a technical sense they are more educational than is this Department, for their prime purpose is to give instruction to students in the sciences relating to agriculture and the mechanic arts, including a more or less extended course in branches generally obtaining in other colleges, and in military tactics—none of which does this Department attempt to do. But in the broad field of the work of this Department they occupy a large space, and in connection with the experiment stations, to be referred to hereafter, they are sensibly invading our lines in some directions, and are in other directions occupying grounds from which we are prohibited, and which in the nature of the case we can not occupy. These institutions are in most instances largely supported by their respective States, especially in the construction of their buildings and the purchase of the farms connected therewith.

The endowment from the United States was created by two acts of Congress, both popularly called the Morrill acts (for their chief promoter, Hon. Justin S. Morrill, United States Senator from Vermont), the first dated July 2, 1862, and the other August 30, 1890. Under the first act Congress donated to each State 30,000 acres of the land, or the scrip for the same, for each Senator and Representative in Congress from that State. These lands and scrip were to be sold by the several States, and the proceeds of such sale were to be held in trust by them for the perpetual endowment of these colleges as unimpaired principal at an annual rate of not less than 5 per cent interest. Some of the States pay 7 per cent. This principal was recently stated at $10,000,000, and the same high authority states that some of these colleges show a "higher average of endowment than any other class of institutions in the country except theological schools." This statement was made prior to the passage of the act of August 30, 1890, by which each State is entitled to

receive for the benefit of such college, out of the proceeds of the sale of the public lands, the first year $15,000, and in each succeeding year an additional $1,000, till the sum shall reach $25,000, after which the sum shall continue at that figure. These colleges are receiving the current year $17,000 each from this fund. Some of the States have not complied as yet with the requirements of the act, but in the present year forty-two States and Territories are recipients, making an aggregate appropriation of $714,000. Surely this increase of annual income must place some of these colleges on a higher average endowment than even the theological schools, heretofore referred to, even without the $5,000,000 which it is estimated the States and individuals have contributed towards their equipment and support. They employ nearly or quite eight hundred professors and teachers, and have over ten thousand students. But Government aid does not end here. Accordingly there is to be added our last subdivision, to wit:

The Experiment Stations.—Each of these is in fact an integral part of the college connected with it. At this date there are forty-seven of them. Under the act of Congress approved March 2, 1887, commonly called the "Hatch act," (for its chief promoter, Hon. William H. Hatch, Representative in Congress from Missouri), the sum of $15,000 is given annually to each State which shall establish an experiment department in connection with the agricultural colleges and departments named in the preceding subdivision, and the department is called an experiment station. The forty-seven stations are being paid this year $700,000, besides an allotment to Oklahoma Territory for the same purpose. This Government aid is supplemented in many of the States by considerable appropriations. The experiments conducted therein are wide in their scope, and much the same as those carried on in this Department, adapted to the conditions and special wants of the localities in which they are situated, and with the further advantages and opportunities, denied to this Department, of having connected with them farms, orchards, and gardens upon which to carry on field experiments, and barns and buildings, as well as stock of all kinds, to enable them to carry on extensive tests in feeding and dairying. This is an educational force of the highest and most concrete form, employing four hundred and fifty workers in all branches of inquiry relating to agriculture, issuing bulletins to 350,000 persons, besides furnishing items and data on agricultural topics for hundreds of newspapers and periodicals in their respective States.

To recapitulate the appropriations by the Government, exclusive of the $400,000 for printing:

For the Department of Agriculture	$2,320,153
Interest on college endowment, first Morrill bill (estimated)	500,000
Direct appropriation under second Morrill bill	714,000
Appropriations for experiment stations	708,000
Total annual appropriation by the Government for this great educational force	4,242,153

THE FORCES SUSTAINED IN WHOLE OR IN PART BY THE STATES.

These have been alluded to under a previous head. These agricultural colleges have been endowed by the States to the extent of $5,000,000, and the experiment stations are to a greater or less degree so aided. In addition, there are several experiment stations endowed and supported entirely by them, and many institutions not heretofore enumerated, in which agriculture is taught. All institutions of learning in which scientific branches are traversed have a bearing, direct or remote, on this great industry. Agriculture is akin to almost every science; closely related to all, second cousin to none. Science walks the furrow with the farmer, is at his elbow as he casts forth his seed, aids him in gathering his crop, rides with him to a speedy market, and suggests avenues to spend his modest earnings. It would be difficult indeed to find an institution of learning that did not contribute in some degree to his comfort, intelligence, or prosperity; hence in a measure all such endowed by the State or its citizens might be remotely included in our classification. But only those agencies are under discussion which are specially established or conducted in the interest of agriculture. There are other agencies besides those heretofore particularly mentioned which in a measure owe their existence to State aid, but which in a large degree are carried on by the gratuitous services or individual contributions, which it was thought proper not to include in this place, but to classify with the next division.

ORGANIZATIONS OF A VOLUNTARY CHARACTER.

These are in names and numbers almost too numerous to mention in this connection. Some of them, like State Boards or Commissioners of Agriculture, and Farmers' Institutes and Fairs, are organized under State law and draw an income from the State treasury, but, after all the labors and duties connected therewith, are in large proportion without adequate compensation—volunteer contributions for the general good. These organizations cover almost every phase of agricultural interest, and are national, State, district, county, and in many cases township in the scope of their action and jurisdiction.

The records of this Department, necessarily incomplete, as these bodies change from year to year, show that of national organizations there are 122, of which the following is a list, as classified:

NATIONAL AGRICULTURAL ORGANIZATIONS.

General in scope:	
Department of Agriculture, Farmers' Congress, Association of Colleges and Stations	3
Orders:	
Like the Grange, Alliance, etc	7
Educational societies:	
Farmers' Progressive Club, Farmers' Institute	2
Horticulture:	
American Horticultural Society, Pomological Society, Gulf State Fruit-Growers' Association	3

Growers of special products:	
Sugar-growers, florists, seedsmen, etc	7
Miscellaneous:	
Fair associations, etc	5
STOCK ASSOCIATIONS.	
Horses:	
General in scope: Trotters, pacers' associations	3
Special-breed associations	12
Miscellaneous	2
Jacks and jennets	1
Cattle:	
General in scope: Cattle-Growers' Association, etc	3
Special breed associations: Shorthorn, Jersey, etc	16
Miscellaneous: Fat stock, herdbooks, etc	4
Sheep:	
General in scope: Wool-growers, etc	2
Associations by the breeders of the several kinds	18
Swine:	
General associations	2
Special associations	10
Dairy:	
General societies	8
Veterinarians	3
MISCELLANEOUS.	
Poultry:	
General organizations	2
Special breeders' societies	3
Bees	3
Fish	2
Silk	1
Total	122

STATE ORGANIZATIONS, MADE UP OF DELEGATES FROM THE SUBORDINATE GRANGES, ALLIANCES, OR BODIES OF THE ORDER.

These subordinate associations run up into the thousands, each with a membership that runs up into the hundreds, and all making compact, systematic orders or associations for the consideration of such matters as may be of special interest to agricultural industry, and which increase and cultivate the intelligence of the individual members. A short consideration of this feature of their work will reveal the fact that there is within the bounds of these lodges a power that is of great moment to agricultural interests. Each subordinate association as a rule covers within the scope of its labors a line of study and discussion of historical and literary matters. Each association is a debating club, with the usual literary exercises, with music, and the highest development of social life according to the standards of the respective communities which they represent. Their meetings, in some cases weekly, generally monthly, are looked forward to with interest, and the programme for each is a matter of earnest discussion and judicious deliberation. Meeting as they do for a specific purpose, which purpose is sedulously carried out, it may be readily conceived that the result can scarcely be otherwise than salutary. Generally one or more persons are connected with each club or association who are recognized as intellectual and literary leaders, usually persons of more than ordinary education and of great force of character. There are other matters, of course, that

are subjects of discussion besides the merely educational and intellectual subjects which traverse the broad lines of the interests of agriculture, national, State, and local. Matters of legislation in some cases are the prime topics of consideration, but in so far as political questions are concerned this article will not consider them beyond the statement that any discussion of matters of legislation, however crude it may be, must lead to a higher appreciation of the duties of a citizen, and to a more intelligent scrutiny of the acts and votes of their representatives in national or State legislatures. But taking a general survey of the whole field occupied by these thousands of subordinate associations, one can not fail to be struck with the increase of knowledge among the people, which may be attributed to a considerable extent to their influence. The personal observation of the writer while for many years acting in a representative capacity most strongly confirmed him in the statement that they are highly educational in their character. During the years that it was his duty and his pleasure to appeal to the intelligence of the people he was struck with the constant advance in their appreciation of public questions and the general development and interest in more purely intellectual and literary pursuits. Within this sphere specially under his observation he felt this fact so sensibly that he often remarked that there had been an advance of at least 25 per cent in these respects. So long as these associations are confined to these worthy objects there are few more potent forces extant in the education of the people. Association always breeds inspiration, inspiration increases activity, and activity accomplishes results. Properly directed these associations are productive of great good, not only for agriculture, but for the general interests of the people. They demonstrate to the farmers themselves the benefits of organization.

Besides these orders there are clubs and associations, special in their character, that have great import to the interest that forms the nucleus of the association. Every convocation of people for the discussion of breeds of cattle, sheep, swine, and other domestic animals fosters intelligence and conduces to the higher education of the one hundred and twenty-two national organizations. The branches respectively enumerated above have, besides their State, their local organizations, all working for a common interest and with definite aim. The highest intelligence, scientific and otherwise, is to be found in them. The making of a herdbook has behind it as much intelligence as the framing of a constitution, differing only in character.

The results of the labors of all the foregoing organizations are national, permeating down through every avenue of commerce, of legislation, and of education; instructing the people, developing special industries, clamoring for rights, discussing principles, and shaping public sentiment. It is a tremendous educational force; in a certain sense discordant and undisciplined, but rudely effective. The student who should ignore this one in writing up the national forces would lack

one of the most essential elements of modern society. One does not need to be a demagogue who comprehends the vigorous activity of this force. True statesmanship must recognize it.

This article would be incomplete were not some consideration given to the influence of the Farmers' Institute. This organization is of comparatively recent date. As a rule, it is not under the jurisdiction of any order, club, or association, but is an organization in which all are associated, and which represents in a certain sense the public at large. In many States they are fostered by contributions from the State treasury, but even in these cases, as before stated, the labor done in them is purely voluntary. Beginning with a few in each State, they have developed in some States until every county, at least every district, is impelled to have its own, aside from those under State auspices. The best talent obtainable in the locality has assigned to it a portion of the programme. Colleges contribute from their laboratories whatever of light science can display; and side by side, theory and practice, experiment and experience, fact and fancy, enlighten and amuse the community. Halls are inadequate to accommodate the crowds, and what the newspaper does at the fireside is supplemented by the speaker on the platform. No age, no cause, has yet been able to dispense with oratory. To-day, as well as in the past, the personality of the speaker earnestly moved by his topic can impress his hearers as can no writer with his printed page. The institute fills this gap in the educational force. In some States it is the most manifest and powerful element in the discussion of agricultural subjects. Institutes have been designated the "people's colleges," in which are discussed the most abstruse principles in a popular way. They have been known to shape the agricultural policy of a whole community. They have shown what a special agricultural industry needs to make it a success. They have encouraged, as in no other way could it so successfully be done, the flagging energies of the almost hopeless worker. They have thrown light upon and suggested the remedy for some disability, and have shown a way of escape from some mysterious malady to plant and animal. They have helped to fight the pest so that fruitage shall be complete and perfect. In other words, all along the line of these institutes, following in their footsteps, we find reanimated hope, inspired courage, increased product, and value received. Some of the States still lack such organizations. They are most deplorably deficient in the very quarter that would promise them the most sensible relief. As a result each farmer goes his own way in the old paths, without conference with his neighbor and consideration of the experience of others, and without a knowledge of what other localities are doing and why they are attaining higher success. It is to be hoped that in the near future every State in the Union will have a systematic, well-devised, thoroughly equipped line of institutes, and that all over the land the best intelligence, the readiest speakers, and the most learned students may be drafted into the service of agriculture.

THE PRESS AND THE LITERATURE SPECIALLY DEVOTED TO AGRICULTURE.

The records of this Department show that there are three hundred and thirty newspapers and publications devoted specially to agriculture. There are besides at least three hundred newspapers, many of which are leaders of public thought, and of large circulation, which have special departments or issues devoted exclusively to agricultural subjects. These newspapers, departments, and issues are in charge of energetic, forceful, intelligent men, with keen discrimination and loyalty to the interests they subserve. Within the last few years, such has been the development of agricultural inquiry, so much has its importance increased in public estimation, that the leading literary monthlies of the country have yielded to the demand of allotment of a portion of their space to articles prepared by persons who, from special study, are fitted to illustrate some phase of the great subject. The laboratory and the field are drawn on for illustrations. The sharpest pens, the most accomplished scholars, and the most earnest workers are now enlisted in favor of agriculture. These publications, in one form or another, reach almost every home in the land. They are read by the fireside, and the information and instruction contained in them find expression on the forum in every agricultural assemblage. Much has been said, and justly said, about the power of the press in molding public opinion and in educating the people. We have made the statement that no single industry in the United States has a greater educational force back of it than has agriculture. No other single industry has three hundred and thirty newspapers and publications specially devoted to its cause. Some of these newspapers have a large circulation, and become heirlooms in the family from generation to generation. The weekly and monthly visitant for the child becomes the weekly and monthly visitant for the man, and for his children after him. The farmer in these days that takes no agricultural newspaper—in these days of sharp competition, of overproduction in certain lines, and of specialties in all—will most certainly fall behind. Every successful farmer in these days must exercise judgment and skill, and his ready assistant and most complete handbook is the well-edited, comprehensive agricultural newspaper, which shall give market prices for his products, as well as information how best to produce them. Items of experience, discussions of principles that the best experience of ages have established, drawn from the world at large as well as at home, find their places in the columns of the newspaper. Facts as to processes, information as to improvements and scientific principles, are placed side by side with current news relating to products at home and abroad.

While a large portion of this agricultural press covers the whole ground of agricultural inquiry, there is a considerable portion that is devoted to specialties, such as to stock of various kinds and the various

industries incident thereto; and in fact there is hardly an association named in the foregoing list of national associations that has not one or more special organs devoted to its interests, in which the latest information with regard to these interests is given, and in which matters most significant and profitable to them are discussed. In short, this power of the press is one of the greatest unclassified, and in a certain sense intangible, forces connected with agriculture.

More progress has been made, perhaps, in coöperation between the Department of Agriculture and the press than in any other direction, for the reason, no doubt, that it presents the least difficulty. All that the press asks is to be promptly informed of all matters of general interest pertaining to the work of the Department. Under the present administration every effort has been made to meet this obvious obligation towards the press of the country. In a general way this effort to spread information through the most natural channel, the press, has been fully appreciated, but yet, strange as it may seem, even in the performance of a duty so obviously simple, the Department has been confronted with some singular criticism, it being occasionally accused of seeking by this means to influence public opinion in its favor, or in favor of some of its investigators, and this, in spite of the fact that the effort has been made in conveying information to give simply statements of fact, without any bias whatever; and that the facts being given to the papers for their own use, they were at liberty to present them to their readers in their own language, or to omit them entirely. Such objections have, however, been exceptional, the appreciation of our work on this line general, and the results, especially in the way of securing timely and well-directed distribution of needed information, so satisfactory as to justify not only a continuance of this plan of work, but the enlargement of its scope as occasion offers.

In this general survey of the field many important factors have been omitted, and many essential elements have not been discussed, but the facts stated and the classification considered can not fail to impress us all, to some degree, at least, with the immense power of the educational forces back of agriculture. They are diverse, in many cases discordant. They are like an undisciplined army, without coherence, without community, shorn of a large measure of its power, but full of energy, vitality, and loyalty to the great industry. How can these forces be marshaled into a more effective, less wasteful energy? Is it available to any leadership that shall not be despotic, autocratic, and destructive to any of the elements? Is it possible to agree upon some plan that shall at the same time indicate and establish the great highways of the movement, and shall still retain the minor paths of individual action? We approach this part of our subject with reluctance, yet feeling the necessity of some consideration of it, and with the hope that we shall not be charged with temerity in its discussion.

COÖPERATION OF THE FORCES.

To a certain extent there is coöperation already. The forces intermingle. Each in a measure is tributary to the others and draws from them. The practical man is indebted to science for some of his best results. Many of the theories of science are exploded when put to the test of practical experience. Along what lines can the coöperation of all these forces be best projected? What shall be the division of work? What aid shall each render to the other?

We have shown briefly what the Department is, and what it is doing, or what are its contributions to this great educational force. Along what lines can it be still further projected, so that in its coöperation with other forces it may become further entitled to leadership, and this in a large measure without any legislation —that is, without any legislation enforcing leadership?

First, it will be agreed in all quarters that the Department has primary jurisdiction over matters which are general to the whole country, and which it can better perform than any other agency; and that it should not, except incidentally, cover the ground that can be as well covered by other agencies.

MATTERS GENERAL TO THE WHOLE COUNTRY.

No individual or locality, were each working for himself or itself, can fully comprehend the influences of other individuals and localities. For instance, no mere local observer of the weather in any specific locality can have the means to obtain information as to the approach of a blizzard from Manitoba, and when it would be likely to reach his station. The broad general sweep of the storm, the elaborate discussion of climate and its effect upon vegetation, must largely be placed in the hands of the agent that considers the whole country. The spread of a disease, the transcontinental movement of a pest, the forewarning of a cold wave, must of necessity be in the hands of a department that represents the whole. Each may do his work in his specific locality, and contribute to the knowledge of the general agent, but the prime agent must be the one who considers the whole subject. There may be as much intelligence in the locality as in the general department, but this intelligence is only local, and is of no general benefit until considered and classified with the intelligence from other localities by the general agent. Again, every matter that is of interstate import must from the necessity of the case be under the control, in so far as its bearing upon the several States is concerned, of the General Government. Every agricultural subject that in any way impinges upon the commerce between the States must in its general scope be assigned also to the General Government. The regulations by which a contagious disease, liable to be transmitted from State to State by commercial transit, is controlled should be made by general authority. No locality acting

for itself can attempt to regulate it without impairing the rights of the whole body politic. All matters that relate to the proper inspection of commodities exported or imported should of necessity be relegated to the same authority. No further illustration on this point is needed. This division of powers inheres in the constitution and in the nature of the case, and while investigations and legislation in many of these matters may be made concurrently by localities, the whole subject in all its bearings must be considered authoritatively by the Department of Agriculture.

WHAT THE DEPARTMENT CAN BETTER PERFORM THAN ANY OTHER AGENCY.

It can collect and classify and exhibit and study the cereals, the forage plants, the fruits, the useful plants, and the fibers, animal and vegetable, of the whole country to better advantage than any single locality. Its agents are everywhere, its information is continental, or should be, its appliances are more extensive, and it has the advantage of the coöperation and contribution of the coördinate Departments of the Government. It, moreover, has the advantage of ready accessibility to foreign lands through the representatives of the Government in foreign nations. It can best study the general effects of climate in the distribution of plants and animals. It can best determine along what lines general experiments, whose effects are generic, should be conducted. As an established agent of the Government it is at hand to take upon itself any special duties assigned to it by Congress. Being beyond the influence of local interests, it can be impartial in its decision of agricultural results. It can be the most effective agent in the collection of agricultural statistics at home and abroad. It can best be the repository of information, past and current, relating to all the varied topics of agricultural import. It can best supervise, within proper limitations, and advise generally the expenditure of all moneys appropriated by Congress for the benefit of agriculture, whether given to the Department or contributed to the States for that purpose. It can best understand and administer relief to the wants of the whole country. It can best collect, purchase, and distribute new and improved seeds and plants, with a knowledge of their adaptation to all the several localities and climates and soils of the country. In other words, from its situation, the means and agencies at its disposal, and the subjects it can generically handle, the Department of Agriculture can be, properly organized and supported, essentially an authority along the lines above indicated.

WHAT THE DEPARTMENT SHOULD NOT DO EXCEPT INCIDENTALLY.

It has not been the policy of the Department in later years, though the contrary has had its advocates, to carry on an experimental farm to propagate and test fruits, cereals, fibers, or flowers. The reason for

this policy is the fact that the Department has but one locality and one line of climatic conditions, whereas the country at large has many, and tests made here would be valuable only for like conditions of soil and climate. This policy remits all that class of experiments in a large degree to the experiment stations and the intelligent experimental farmers, horticulturists, and florists of the country. It is not desirable that the Department should carry on dairy farms or experiments in feeding live stock, for much the same reasons as the foregoing; but it is desirable that the Department should canvass the principles, should become the general repository of information, should be competent to give advice in all these lines when called for, and that it should make, as before stated, a special study of the laws of the distribution of plants and animals and the soils to which the plants are best adapted; and for the greater reason that it is charged, and always has been, with the purchase for distribution of improved and valuable seeds and plants.

This distribution of improved and valuable seeds and plants is based upon sound policy, because based upon natural law. A discussion of why this is so, and to what extent this power has been of value to the country, may be found in my article in the Report of 1890, referred to above. It is not desirable that this Department should dominate and control all the experiments carried on by the experiment stations, for the reason that no one man and no Department is large enough to comprehend the wants and the conditions of forty-eight States and Territories; but it is desirable that the Department should be fully posted in the experiments of the past, and should be thoroughly conversant with the experiments in the present, and should be such a well-equipped repository with reference to the results as to advise the stations and the country with reference to the same. By this means useless experiments and unnecessary duplication may be avoided, and the frittering away of this force, which may be of such great good to the country, may be prevented. It is no imputation on the zeal or energy of the stations, or in fact on the intelligence with which they are managed, to say that they are thrashing a great deal of old straw for want of the information that it has been thrashed before. It is not desirable that the Department should interfere with the details of the expenditures of the several stations, except in so far as to see that they follow the general and obvious lines of the legislation establishing them. The Department should have at least the right to inquire and report to Congress with reference to the administration of each of the stations, so that Congress in its annual appropriation may possess the information necessary for guidance in considering the desirability for its continuance. I believe that this will in time become a necessary requirement. It is certainly proper that when money is appropriated out of the National Treasury, the National Government should follow it to the extent of inquiring as to whether it has been properly expended, and there is no agent that is certainly more competent to do this and more

fully in sympathy with the labors of the stations than is the Department of Agriculture.

While it is the policy of this Department not to carry on field experiments itself, and that such should be remitted to the several experiment stations, it is very desirable that it should have such coöperation with the different stations as will enable it to use them in the making of such experiments as the information it possesses makes desirable. While I am not prepared to say that the stations should be compelled to make experiments indicated by this Department, it is desirable that in some way they should become the recognized agents of the Department in making such experiments. To a certain extent the Department at the present time is carrying forward such a line of coöperation, especially in the West and the South, relative to experiments with forage plants, and in sporadic cases requests have been made upon the stations for specific investigation and experiment. In these instances coöperation has generally been hearty, and the requests readily complied with, or the effort at least has honestly been made to do so; but such are the distractions of the workers in the various experiment stations, such the multiplicity of experiments being carried on and the pressure of local wants, that in many cases the request has been in the nature of an imposition of additional duties upon already overburdened shoulders, and in very many cases we feel that the results have not been such as they would have been if we had had sole charge of the experiments ourselves. Yet there has been enough of coöperation and results to justify us in the hope that in the future the sphere shall be enlarged, and that there shall be in the plan of every experiment station a definite place, and also the proper man or men, to carry on for us an experiment, if the same has not already been included in the general work of the station. It has always been my theory that these stations should in certain lines be the direct and responsible agents of the Department of Agriculture; that, having now the right to indicate lines of experiment and give advice to the stations, it should be afforded some means to enable it to see how to bring about results along such lines. Whether this can be more easily accomplished by affording this Department the means with which to pay for such experiments, coupled with the adjustment of the plans of the stations to perform them, or whether there shall be an element of directory power added to enforce this right to advise, now already possessed, is one of the debatable questions. I have been inclined to favor the first proposition. In that case the coöperation would be mutual, this Department affording the means and giving the advice, and the station including the work as a part of its plans. Occupying, as this Department does, the general field and looking the ground all over, it is or ought to be more competent to judge with reference to desirable lines of experiment for the whole country than any single station acting within its own sphere, and the means and facilities should be afforded for the joint work of these two great agencies of the country in agricultural investigation and experiment.

I can not think that it is desirable that this Department should inaugurate and carry out a general system of farmers' institutes. The effort to do so would break down from its own weight. These may be left largely to the control of the different States and localities and the different associations promoting them. It is desirable, however, that the Department should have a force of thoroughly skilled specialists, with the ability to participate in the discussions incident to these institutes. As a corollary to such a force the Department should be more fully equipped with the facts of each specialty than any other agency in the country. It should be competent, and it should be its duty, to give forth this information on points that shall supplement the equipment and the knowledge of the general institute workers, local or otherwise. So also with regard to the meetings of the various voluntary associations referred to which are devoted to special lines of agriculture. These, as well as the farmers' institutes, have a right to expect from the Department assistance of the character indicated.

I should be glad to have the officers of all associations established for the benefit of agriculture, or of any line of agriculture, bear in mind the fact that acquaintance must precede mutual service. The efficacy as well as the promptness of service to be rendered to such associations by the Department would be greatly aided were they promptly to place themselves in communication with the Department through their secretaries. Such information as the Department might have, calculated to be of special use to them, would then reach them directly, while they would otherwise have to obtain the same by special application as the result of learning indirectly that such information is to be had. On the other hand, so far as the Department itself is concerned, such local organizations furnish eminently proper channels through which not only to reach the more intelligent farmers, but through which information may be readily obtained by the Department and its workers in regard to local agricultural matters. This is at least a simple step towards the great work of coöperation, the necessity for which I have endeavored to show, and one the initiative of which must come from without, not from within, the Department; but I may be allowed to take this occasion to publicly express the readiness with which such a step in the direction of coöperation would be received by the Department.

After considerable study of the subject I am forced to the conclusion that it is not the function of this Department, by its publications, to take the place of the ordinary agricultural newspaper. All of the lines of information, historical or otherwise, which for the most part are well known, or which are current in every intelligent publication, should not as a rule be entered upon. The Department should not run a newspaper, at least in form and substance as now published. Its publications, as a rule, should cover its own work, which should be fully elaborated and clearly stated in language readily comprehended by the

average intelligent farmer, avoiding controversy, rejecting platitudes, and so far as possible repeating no fact generally known. "Farmers' bulletins," of huge editions, are liable to encroach, in my judgment, upon the domain of the agricultural newspaper. There is a clear distinction to be drawn, which with a little better understanding would be of great benefit to both sides in interest, and lead to a more hearty coöperation between the Department and the press. Still there are numerous publications demanded from this Department that occupy an intermediate station. Being the general repository of facts, and being in certain respects more thoroughly equipped than any other agency, there are special interests which may justly be covered by a Departmental bulletin. As a rule, however, they should be devoted to some specific purpose, and should contain within their pages the latest information on the subject obtainable by the Department. Covering the whole ground of the special inquiry, the constituent who may be specially interested in the subject is enabled to study it with more benefit than he could derive from following the sporadic articles or suggestions of the current newspaper. Occasionally it is desirable as a matter of economy on the part of the Department to issue a bulletin on subjects that are more or less treated of in the press. The correspondence of this Department shows that there are thousands and tens of thousands of letters annually received on the commonest and generally best known subjects. Each letter in due course has to be answered, sometimes briefly and sometimes requiring hours and days of preparation and compilation. In the administration of the Department and a proper classification of these general requests a brief bulletin or circular might be printed which would anticipate and answer perhaps one-half of such letters of inquiry. This plan is in no sense an attempt to invade the domain of the press. It should be used, as before stated, for the economical transaction of the business of the Department. This Department is a Department for the people, and every man who feels moved to ask a question or apply for information, however commonly known, is entitled to a courteous answer giving such information, and not referring him curtly to the ordinary avenues accessible to every intelligent reader or student. In the nature of the case these letters cover every possible known subject, and the correspondence entailed by them is one of the burdens which it is not desirable to unload; but the necessity for this class of circulars or bulletins need in no perceptible degree modify the policy of this Department to keep substantially within the limits of its own work in its publications. This work, however, it must be understood, is not always necessarily original work of which all the elements were heretofore unknown. Compilation of facts, classifying of information, adjustment of data, are just as much the work of the Department as the finding of a new remedy, a new plant, a new pest, or a new process. Hence the Department would be untrue to its obligations, would emasculate its virility, if it should abdicate any of

its functions for research or investigation, and every path that it is authorized to tread should lead to the widest horizon of publicity.

Finally, in order more effectually to carry out the foregoing suggestions, it is manifest that the Department should be more thoroughly equipped, even in the lines of limitation laid down. It should have a collection of cereals from all climates, classified, arranged, and studied by competent men; it should have models of all fruits, prepared with such discrimination as should show the effect of climate on their growth; it should have a complete collection of wools and other fibers scientifically arranged; it should have such a collection of every known product indigenous or adapted to all or any of our soils and climates; it should have a complete collection of all agricultural implements, arranged so as to show the development and historic progression of inventive genius as applied to agriculture; it should have a complete collection of soils, with their chemical analyses; it should have preserved in its museum or archives the visible result of every chemical analysis and every experiment, so far as it is possible to make it visible; it should carry to completion an exhaustive biological survey of the country, with special reference to the distribution according to climatic conditions of plants and animals, with a study of their adaptation to our varying soils and climates; it should have complete and reliable statistics of every agricultural product in the United States and of all competing products in foreign lands; it should count every hoof and estimate the value of every domestic animal; it should be in constant touch with the markets at home and abroad; it should know every pound of butter and cheese produced, and should be thoroughly versed in the processes for the best, the greatest, and most economical production of the same; it should know the locality and the spread of every pest and disease, and should thoroughly understand the remedies for and means of exterminating the same; it should have a sufficient force and sufficient means to carry into effect every operation and duty assigned to it; it should be equipped with persons competent to explain on the platform and to put into its publications the fullest, amplest, and latest information with reference to any agricultural specialty or interest in the United States. In other words, the Department of Agriculture should be so amply endowed with material, money, and men as should make it an authority on all agricultural questions, capable of assisting in every laudable way the experiment stations and colleges and all voluntary organizations, clubs, and associations. It should be a mine of information to the press; should be so established in the confidence of the people that these same people, in their respective localities, acting through their organizations and speaking through the press, would appreciate with growing interest the effort of their national agent; and should always be able and ready to coöperate with every other agent, to the mutual advantage of all.

REPORT OF THE CHIEF OF THE BUREAU OF ANIMAL INDUSTRY.

SIR: I have the honor to transmit herewith my report, which contains a brief statement of the more important work accomplished by the Bureau of Animal Industry during the year 1891. For many interesting details of the work, and for the reports of agents, inspectors, and other employés, I must refer you to the Seventh Annual Report of the Bureau of Animal Industry.

Very respectfully,

D. E. SALMON,
Chief.

Hon. J. M. RUSK,
Secretary.

OPERATIONS OF THE BUREAU.

The work of the Bureau of Animal Industry during the past year has been much more extended and successful than ever before. In the endeavor to place our animals and meats upon the foreign markets in such a condition and with such guarantees that no doubt could be raised in regard to their healthfulness or wholesomeness, a number of new lines of service were instituted.

INSPECTION OF EXPORT CATTLE.

Export cattle have been inspected and marked for identification with a numbered tag in the ear at the first stock yard in which they were admitted. A record of all these cattle has been kept, showing the section of the country from which they came, and the farm upon which they were fed. These cattle were afterward examined at the port of shipment, and a certificate of inspection issued to accompany them. It has been the endeavor to throw around export cattle all possible safeguards against exposure to any form of contagion during their shipment from the interior to the seaboard. Vessels carrying these cattle have been inspected and required to furnish suitable quarters for their transportation in a humane manner and healthful condition. Three American veterinary inspectors were stationed at the principal foreign animal wharves in Great Britain in August, 1890, and it has been the duty of these inspectors to report on the condition of the cattle arriving. In case the British inspectors reported any contagious disease as existing among these cattle, it was the duty of our inspectors to forward full particulars, together with the tag numbers of the suspected animals, so that their history could be traced.

MEAT INSPECTION.

In addition to those measures applying to the shipment of live cattle, an inspection of meats has been inaugurated. Cattle slaughtered for the export or the interstate trade are inspected by a veterinarian before they go into the slaughterhouses, and other veterinary inspectors are stationed upon the killing floors to examine the viscera of each carcass as it is dressed. Every quarter of this beef bears a numbered tag identifying it as inspected meat. In the case of hogs, two or more samples for microscopic inspection are cut from each carcass while it is on its way to the cooling-room. Each carcass is numbered with a printed tag, and a duplicate number is put into a tin box with the samples. These samples are then taken to the rooms where the microscopic inspection is performed, and when examined a report giving the results of the examinations is returned to the inspector at the slaughterhouse. The carcasses remain in the cooling-room from twenty-four to forty-eight hours before going to the cellars where they are cut and cured, giving ample time for the microscopic inspection to be performed without delaying the operations of the packers. All carcasses found affected with trichinæ are rejected, and only those which have passed a most rigid microscopical examination are allowed to go into the cellars from which the inspected meat is shipped.

In addition to the inspection and quarantine of cattle coming from other countries than North and South America, which has been maintained for a number of years, an inspection has recently been instituted on all animals imported into the United States from the several countries on the American Continent. In some cases it has been necessary to quarantine these animals for a limited period, in order to prevent the introduction of disease.

The inauguration of these different and distinct lines of work has required much time and careful investigation to elaborate the details of the regulations, while the organization of a force for carrying on the work has not been without its difficulties. Considering that a service of this kind had never before been attempted in this country, it must be admitted by everyone that it has been performed more successfully and has caused less delays or embarrassments to the enormous trade which it controls than was anticipated. Some questions of great importance to the country have been made prominent, and are likely to be settled by these inspections.

INSPECTION OF AMERICAN CATTLE AT BRITISH PORTS.

One of the first questions demanding attention was the nature of the disease discovered in the American cattle landed in Great Britain, and which had been pronounced by the British inspectors to be contagious pleuro-pneumonia. There were many facts which for years had led to the suspicion that there must be an error of diagnosis in most if not all of these cases. For example, cattle coming from the interior of the country where pleuro-pneumonia had never existed, and shipped through uninfected districts, were as likely as any to be declared affected with this disease. For more than two years there has been such a small number of outbreaks of pleuro-pneumonia in the United States—and these were confined to districts strictly quarantined—that it did not seem possible that the export animals could be infected. It is gratifying to report that since American inspectors have been stationed in Great Britain—about fifteen months ago—there have been but three cases of contagious pleuro-pneumonia reported by the British inspectors as affecting American cattle. In each of these cases the American inspec-

tors protested against the diagnosis, and reported to this Department, giving the tag numbers of the affected animals. A careful investigation was then made by this Department, and it was found that no disease of a contagious nature had existed on the farms where these animals were fed or in the localities from which they came; that pleuro-pneumonia had never existed in those localities, and that there was no possibility of the animals being infected with this disease in transit. The American inspectors considered the disease to be catarrhal pneumonia, caused by exposure during the voyage. As the cases occurred in March and April, when the weather was cold and stormy, there was good reason to believe their opinion to be correct, especially as the animals had not been exposed to the contagion, and as it is admitted by all that it can only be contracted by exposure to an animal already affected by it.

The British inspectors receded from their position in the case of one of these animals. Specimens from the lungs of the others were submitted to Prof. Williams, principal of the new Veterinary College of Edinburgh, one of the most eminent veterinarians in the profession, who, as well as his son, a professor in the same institution, decided that they were affected with a disease which they designate as *broncho-pneumonia catarrhalis*. This was also the opinion of Prof. J. E. Ryder, of the American Veterinary College, who was in England at the time. Taking the opinion of these distinguished gentlemen, in connection with the history of the animals as established by the investigations of this Department, it became plain that the diagnosis of contagious pleuro-pneumonia, as affecting the animals in question, could not be successfully maintained. The inspectors of the British agricultural department were unwilling, however, to concur in this conclusion.

In June, 1891, an editorial article on this subject appeared in the Journal of Comparative Pathology and Therapeutics, which is edited by Prof. McFadyean, one of the inspectors of the British agricultural department. This article states the conditions under which cattle from the United States are landed and slaughtered in Great Britain, and gives a brief summary of the difference of opinion as to the nature of the lung disease which has occasionally been found among them. It goes on to say that two possible explanations of this state of affairs suggest themselves, first, that pleuro-pneumonia might exist in the United States in districts regarded as free from the disease; or, second, that the British veterinary inspectors made a mistake in diagnosis. Referring to the two cases discovered in April, 1891, about which there was a difference of opinion, it says that they were found after slaughter to present lesions which the British veterinary inspectors considered to be those of contagious pleuro-pneumonia. The correctness of this diagnosis was confirmed by the veterinary advisers of the board of agriculture in London, but Veterinary Inspector Wray, the American inspector stationed at London, disputed the accuracy of the diagnosis, and maintained that the lesions in question were not those of pleuro-pneumonia. Portions of the diseased lung from one of these animals were submitted to Profs. Walley and McFadyean, and their opinion was in consonance with that of the home authorities. After mentioning that specimens from these lungs had also been submitted by Dr. Wray to Prof. Williams, and the opinion of the latter, the article says:

It has, we believe, been generally held in this country that the post-mortem diagnosis of contagious pleuro-pneumonia is not a matter of great difficulty to anyone who has had much experience of the disease; that, in fact, an identical pathological picture is never met with in any other affection; and it is hardly possible to conceive an explanation of the flagrant difference of opinion that has arisen regarding

the present case. If Prof. Brown and his assistants at the board of agriculture do not know pleuro-pneumonia when they see it, it can not be from lack of experience; and since the American inspectors were stationed in this country in order to control the diagnosis of the British inspectors, it must be concluded that they were selected from those who had had abundant opportunity to make themselves acquainted with the pathology of pleuro-pneumonia. It is within the range of possibility that on American soil there exist other bovine diseases having lesions not distinguishable from those of contagious pleuro-pneumonia, and something to this effect was said not long ago by Dr. Salmon, the veterinary adviser to the United States Government.

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We need hardly say that we do not quote this passage in order to show what are Dr. Salmon's views regarding the morbid anatomy of pleuro-pneumonia, for if he had any intention of explaining how his subordinates sent over to Great Britain were to distinguish pleuro-pneumonia from other diseases with which British veterinary surgeons had confounded it, his effort was singularly unsuccessful. One thing is made clear, however, namely, that Dr. Salmon considers it difficult to diagnose a case of pleuro-pneumonia unless the history of the animal is known, and this, of course, must refer to post-mortem diagnosis.

We do not share that opinion, and we do not find in the action of Dr. Wray any evidence that he shares it. Be it observed, Dr. Wray did not say with reference to the lungs of the Deptford cattle, "these lesions resemble those of pleuro-pneumonia, but they may be due to something else, and unless you know the history of the animals, you have no right to pronounce the disease pleuro-pneumonia;" on the contrary, he appears to have experienced no difficulty in deciding that the lesions were *not* those of pleuro-pneumonia.

In other words, Dr. Wray carries in his mind's eye a picture of what he takes to be the lesions of a pleuro-pneumonic lung, and he did not find it in this case. In the same way Prof. Brown, Mr. Cope, and the other veterinary officers of the board of agriculture also carry with them a mental picture of the appearances of such a lung, and that picture is different from Dr. Wray's. Both can not be right, and until the American authorities condescend to define these other diseases, vaguely alluded to by Dr. Salmon as having lesions analogous to contagious pleuro-pneumonia, they can hardly expect that when British veterinary inspectors in this country encounter in American cattle "the condition of lungs which resembles pleuro-pneumonia, but which also resembles other diseases," they will pass it over because it may not have been pleuro-pneumonia. In short, if there is a doubt, and probably there was none in this case, home interests must get the benefit of it.

This article was evidently written by a veterinarian, and the writer should, consequently, know that whereas it is sometimes difficult to diagnose contagious pleuro-pneumonia, there are other diseases of the lungs which may be diagnosed with great certainty. For this reason, there is no inconsistency between the position adopted by the chief of this Bureau as to the difficulty of diagnosing isolated cases of pleuro-pneumonia when no history of the case is known, and the position so positively assumed by Dr. Wray, that the two animals in question were affected with broncho-pneumonia, and not with contagious pleuro-pneumonia. Between these two diseases there is no doubt some superficial resemblance, but those who have given careful study to the question are usually able to diagnose broncho-pneumonia without hesitation. In any case an animal can not have pleuro-pneumonia unless it has been exposed to the contagion of that disease, and, conversely, if it has not been so exposed it can not have that disease. One of the most important reasons for stationing inspectors in Great Britain was to have an official record of each individual animal from the time it left the farm in this country until it reached the docks abroad. And by means of this record it has been positively shown that the animals condemned by the British inspectors had not been exposed, and consequently could not have been affected with pleuro-pneumonia.

In October, 1891, there appeared in the Veterinary Journal and Annals of Comparative Pathology, published in London and edited by Dr. George Fleming, an editorial so ably prepared and withal so free from bias that it is quoted in full as a most valuable contribution for the elucidation of this question:

CONTAGIOUS PLEURO-PNEUMONIA AND INFECTIOUS BRONCHO-PNEUMONIA OF BOVINES.

It is now some years since a diversity of opinion occurred with regard to the presence of contagious pleuro-pneumonia in a cargo of American cattle disembarked at Liverpool, and which were condemned because one of them was found to be affected —according to the Government authorities—with that disease; but which, in the opinion of Prof. Williams, after inspection of the lung lesions, was not that malady, but another. Quite recently a similar case occurred among another cargo of American cattle, and the same veterinary authorities stood in the same position with regard to its nature, this time Prof. Williams being supported by the United States veterinary inspector, who has been sent to this country by his Government to see that the cattle imported from the States are not unfairly condemned. This course was deemed necessary from the fact that many cargoes arriving from that country have been accused of being infected with the lung plague, which the veterinarians on the other side of the Atlantic have declared it could not be. The recent case just referred to has caused a more than usual amount of interest from the striking difference in opinion as to the nature of the changes in the lungs of the diseased animal; in fact, as to whether these alterations were those of lung plague or another affection. Not long ago we were shown photomicrographs of *pleuro-pneumonia contagiosa* and this American cattle disease which Williams has designated *broncho-pneumonia catarrhalis,* and certainly the difference in appearance between the two is very marked.

This divergency in opinion as to the nature of the malady for which shiploads of American cattle have been condemned has had no result other than that the opinion of the English Government experts has prevailed, and nothing further has been done to settle the matter, though astonishment may be expressed that experimental proof, so easily obtained, was not resorted to.

Strange to say, corroborative evidence in favor of Williams's contention has sprung up in a very unexpected quarter, and on the statement of one of the foremost veterinary pathologists in Europe, who probably knew nothing of what was taking place in England in reference to this matter.

At the meeting of the Central Veterinary Society of Paris, on July 23, Prof. Nocard, of the Alfort Veterinary School, brought forward the subject of "An infectious broncho-pneumonia in American cattle," and to this subject, seeing its great importance, we will devote some attention. It appears, from Nocard's statements, that during last winter at La Villette, the Parisian cattle market, several thousands of fine American cattle from the United States, chiefly from Virginia, Indiana, and Illinois, were exposed for sale, and on three different occasions the sanitary officers of the market observed that some of these animals were affected with an unusual disease of the respiratory organs. These officers—Redon, Godbille, and Blier—are well-known veterinary surgeons, and it was in their name as well as his own that Nocard addressed the meeting. In November last, in a lot of more than 400 cattle direct from Illinois and Indiana, one died and two were very ill, the symptoms leading to the suspicion that they were affected with contagious pleuro-pneumonia. The two ailing animals were at once killed and an examination of their lungs was made by Godbille. There was no pleurisy, but the interlobular septa of hepatized portions was the seat of a very abundant serous infiltration. Before arriving at any decision as to the nature of the malady, and in view of the serious importance of the case from the number and value of the animals, the two sets of lungs were sent to Alfort to be submitted to Nocard. He reports that at the first glance a section of the hepatized tissue presented the appearance of a recent lesion of contagious pleuro-pneumonia. The tissue was dense, compact, friable, and the color varied from bright red and deep brown to almost black, while the lobules were isolated from one another by thick septa, infiltrated with a considerable quantity of yellow limpid serosity. But a closer examination showed that there were notable differences between these lesions and those of lung plague. The connective-tissue infiltration was less abundant and the serum less albuminous and not so yellow or limpid, and here and there pressure on the excessively distended lymphatic sacs extruded small, white, smooth, and firm fibrinous concretions. The tissue of the lobule in the greatly thickened girdle of connective tissue had not the uniformity of tint and consistence that characterizes the pleuro-pneumonic lesion. It was harder, more manifestly hepatized in its center than at its periphery. *The lesion proceeded from the bronchule, and not from the perilobular tissue.* In pleuro-pneumonia it is the opposite; for in it, when the lesion is very recent, lobules are often found the tissue of which is dense and dark at the periphery, while in the center it is yet rosy, elastic, and permeable. There was another important differential sign. Pressure caused a notable quantity of thick, viscid, light yellow pus, analogous to that observed in certain forms of verminous broncho-pneumonia, to issue from the bronchules, but a microscopical examination of this fluid and of the lung pulp did not lead to the detection of ova, embryos, or worms of any kind. The bronchial mucous membrane was

inflamed, thickened, and corrugated, and more or less denuded of its epithelium, while the submucous connective tissue was infiltrated with yellow serum, and considerably thickened in places.

This muco-pus from the bronchules was found to contain an abundance of short, oval, motile bacteria, which appeared to be the only microbes present. The organisms were also found, as if in a state of pure culture, in the hepatized tissue, and more especially in the limpid serosity that distended the perilobular lymphatic sacs. This single character alone sufficed to affirm that the lesion was not of a pleuro-pneumonic kind; for it is well known that the lung serum in that disease is very poor in figured elements, and that when it is collected pure from the infiltrated septa it does not usually contain any microbes.

In this instance the microbe which existed in such numbers in pulmonary lesions belonged to the large class of ovoid bacteria, of which the rounded poles fix anilinated coloring matters more strongly than the center.

Nocard points out that fowl cholera, duck cholera, the septicæmia of rabbits and the ferret, the game plague (the *wildseuche* of the Germans), the *barbone* of the buffalo, pneumo-enteritis of the pig, etc., all have analogous microbes, which can only be distinguished from each other by their collective biological characters, and more especially by the effects of their inoculation on different kinds of animals.

After describing this microbe in detail, and its cultivation, Nocard refers to the results of inoculation with it. These results were always the same—muco-pus in the bronchia and serosity in the pulmonary connective-tissue septa, whether the cultures were old or new. Mice, rabbits, guinea-pigs, and pigeons, when inoculated subcutaneously with two or three drops of the serum or the culture, succumbed in less than forty-eight hours, without œdema at the point of inoculation, with intense congestion of all the viscera, but without any definite localization. The blood examined soon after death did not show many bacteria, but they increased the longer the interval that elapsed, and especially if the pipettes containing the pure blood were left on the stove for a few hours. When the fluid was injected into the peritoneum, death resulted in fifteen to eighteen hours, with a purulent peritonitis of great intensity; the pus was very abundant, viscid, and not fibrinous, and contained an enormous quantity of bacteria.

Sheep and calves, inoculated subcutaneously or in the trachea, with a cubic centimeter of culture, of serosity, or of virulent pus, did not die; they suffered, however, from intense fever, and remained prostrate, without appetite, for some days, but soon regained their normal condition.

Intrapulmonary inoculation was more effective; as a calf of eight months and a ram of two years, inoculated in the right lung with five drops of peritoneal pus from a guinea-pig, died in less than forty-eight hours with fibrinous pleurisy and exudative broncho-pneumonia analogous to that observed at the autopsy of the American cattle; the lesions were extremely rich in bacteria.

A curious fact was elicited in these interesting experiments. A calf and two sheep, previously inoculated subcutaneously, then in the trachea, afterwards resisted the effects of intrapulmonary inoculation with ten drops of virulent culture; their temperature remained for three days above 40.5° C., there was great sensibility of the thoracic parietes, and dullness in the inferior two-thirds of the inoculated lung; but all the morbid symptoms disappeared promptly, and subsequently they have undergone two other intrapulmonary inoculations of serum and culture fluid, without any apparent trouble. It would, therefore, seem that, though subcutaneous inoculations will not kill large animals, it will confer such a degree of immunity as will enable them to resist a pulmonary, and otherwise fatal, inoculation. The pig, fowl, dog, and rat resisted all modes of inoculation.

Nocard arrives at the conclusion that the disease does not resemble any known in France, and he considers it probable that it is a malady special to American cattle; and that it is not rare is proved by the fact that since the month of November he has seen it—always presenting the same features—in other lots of cattle from the United States—Indiana or Illinois. He is inclined to think that it is the affection which is known in the Western States as the "cornstalk disease;" but however this may be, it results from his observations and investigations that American cattle are liable to a microbic broncho-pneumonia, hitherto unknown in France; and the serious question, therefore, arose as to whether there was any danger to be apprehended from the importation of such animals, a question put to Nocard by the French agricultural administration. From his attentive observation of facts, and the experimental study of the conditions of contagion, he concluded that the malady had only very feeble contagious properties. In the three very large importations in which the disease was detected, notwithstanding the considerable number of animals in each and their long and close contact with each other, the affection did not spread, and the cases remained isolated ones. From all these facts, his opinion was that there was no urgent danger or any necessity for special measures.

The question that now arises on this side of the Channel is one of some moment,

not only from an economical, but also from a pathological point of view. Many cargoes of American cattle have been condemned because it was found that one or two in each lot were affected with what was supposed to be the specific and only too well-known lung plague. United States veterinary surgeons have strenuously denied the existence of that malady among the cattle, and Prof. Williams, on two occasions when the matter has been referred to him, has concluded that lung plague was not present, but that the lesions were those of catarrhal broncho-pneumonia; and now Nocard finds what we are almost forced to conclude is the same disorder, examines it and experiments with it as a scientist of his position and responsibility should do, and, *mirabile dictu*, arrives at the same conclusion as Williams, and even designates it by the same name. It will be an extraordinary revelation if what has been considered as contagious pleuro-pneumonia in American cattle should turn out to be something very different, and of little, if any, importance. The slaughter mania is a terrible barrier to pathological observation; and little as we have done in this country in the way of scientific investigation of animal diseases, it is to be hoped that the example of France in this instance will not be without effect. It is quite possible that the American cattle found in La Villette market would have been condemned here as infected with contagious pleuro-pneumonia, and the usual consequences would inevitably follow. Must we again say that in this instance, as in so many others, "They manage these affairs better in France?"

PROTECTIVE REGULATIONS.

The United States is now practically free from contagious pleuro-pneumonia. During the last seven months no case has been found on Long Island or in any part of the State of New York. The only cases discovered during this time have been in a few small herds of dairy cattle in a very small district of New Jersey. This district is under the most rigid quarantine regulations, and every diseased and exposed animal has been slaughtered immediately after its discovery.

As there is no other disease among American cattle which is liable to be communicated to the animals of other countries, the time has come for a consideration of the regulations enforced by Great Britian and its dependencies in regard to animals from the United States, and those enforced by the United States in regard to animals from these countries. That there is considerable pleuro-pneumonia in widely separated sections of Great Britain, and that this disease has during the past year affected some of the most valuable herds of cattle in that country, is freely admitted. There is, consequently, much more danger of the disease being conveyed to this country by imported animals than there is of its being conveyed from the United States to either Canada or Great Britain.

There is no longer any reason why regulations should not be adopted by the United States for the protection of its live-stock interests as rigid as those which are enforced by the countries just mentioned. This country has been very lenient in the matter up to the present time, and has made regulations which would not interfere materially with the importation of animals, although it has been believed that they were sufficient to prevent the introduction of disease. There is, however, some doubt as to whether a quarantine of three months' duration is sufficient to absolutely guard against the introduction of pleuro-pneumonia when this disease exists in countries from which animals are imported.

Great Britain holds that such a quarantine is not sufficient, and consequently all cattle from the United States are slaughtered upon the docks where landed, within ten days after their arrival. This regulation goes still further and includes sheep and swine as well as cattle.

The Dominion of Canada also enforces a quarantine of three months on all cattle imported into that country from the United States.

If a quarantine of three months is not sufficient to prevent the introduction of pleuro-pneumonia, then we have not only been endangering our stock by allowing importations upon such conditions from Great

Britain, but the Dominion of Canada has permitted its stock to be exposed to the same danger, and her cattle for this reason must be dangerous to the cattle of the United States when they are imported into this country.

There are also the same diseases of sheep and swine existing in Great Britain and Canada as exist in the United States, and there is the same danger of bringing such diseases here with those animals that there is of introducing them into Great Britain and Canada with the same species of animals from the United States.

To give our stock owners the same protection, therefore, which Great Britain insists is necessary to prevent the introduction of disease into that country, we should establish regulations requiring that all cattle, sheep, and swine imported from Great Britain and Canada should be slaughtered at the ports of entry within ten days.

While our experience in the past has not, in my opinion, made it necessary to suggest such stringent regulations as a sanitary measure, it would seem that our breeders should have the same protection as is enforced by other nations against this country.

PORK INSPECTION.

Since the removal of the prohibition on American pork by Germany, on September 3, 1891, there have been frequent newspaper articles published in that country containing the most absurd statements criticising the work of inspection and disparaging the quality of our meats. It was said that there were but two or three inspectors at a great packing center like Chicago or Kansas City, and that the hogs were cut into pieces at the time of slaughter, so that it was impossible to identify these after the specimens had been examined microscopically. As is stated elsewhere in this report, the carcasses are not cut until from twenty-four to forty-eight hours after slaughter, so that there is ample time for microscopic inspection and for the rejection of all carcasses found to contain trichinæ. There are also a sufficient number of inspectors and microscopists employed to inspect the pork in as rigid and careful a manner as such inspection is carried on in any part of the world. A system of reëxamination has also been adopted by which the work is controlled, and by which if any errors were committed they could be readily detected.

At the time the prohibition was removed, and on account of an imperfect understanding of the conditions under which pork would be received into Germany, a considerable number of shipments were made by various dealers, which had not been inspected, and which were not accompanied by the certificates of this Department. Some of this pork appears to have been admitted and sold on consular certificates, and there is no doubt that some of the criticism directed against our inspection was based upon an examination of this meat.

The following articles, translated from the Frankfurter Zeitung, and forwarded through the Department of State by Consul-General Frank H. Mason, indicate that the greater part of the derogatory statements were inspired by those whose personal interests are opposed to the importation of American pork into Germany:

The Hamburger Nachrichten publishes an article on "The swine import," which was obviously written by its best collaborator, Prince Bismarck. Naturally, the article is directed against the recent abrogation of the decree forbidding the importation of American pork. The germ of this opposition of the former imperial chancellor toward his successor is revealed, not so much with reference to the admission of American meat as against the American certificates of inspection. What Prince Bismarck says contains not an atom of fact, but a mountain of sus-

picions. Not only the American inspectors, but the officials of all other foreign countries, are accused of being governed in their official actions more by sentiments of "patriotism" than by considerations of justice. This kind of controversy would be trivial and untenable if Minister Caprivi had accepted the suggestion which the Frankfurter Zeitung offered at the beginning of the current year, viz, that American pork should be inspected, on its arrival at German ports, by German officials.

In that event it would not have been necessary to trouble the American Government with any official microscopic inspection of meats intended for export. The American meat would have been just as carefully inspected for trichinæ by the German officials, and the wind would have been taken out of the sails of all these breezy polemics about the inefficiency of the American, and the infallibility of the German, inspectors. We should then have been brought more directly into contact with the question, which, after all, is the one of most importance for Germany, viz, whether the German meat inspectors are really infallible as Prince Bismarck seems to believe. The recent occurrences in Mühl-Rädlitz, Altona, and Nieder-Löhme show clearly how carelessly the German officials conduct their examinations for trichinæ. While the American officials are accused, *a priori*, of carelessness and inefficiency, without a single fact being adduced to sustain such charge, there are, on the part of the German officials, obvious and undeniable facts which prove their neglect of real dangers to the public health. * * * We have recently published the judgment of a German university hygienist that the danger lies not in American but in German trichinæ. We can complete his verdict. It is not the American, but the German trichinæ-inspectors who are dangerous to German pork consumers; for, if the German inspectors were efficient, it would be easy, through them, to protect German consumers from the alleged inefficiency of the American officials. But, if the German inspectors are careless and inefficient, the health of German consumers is definitely compromised.

BREMEN, *November 10.*

At the inspection station for imported freshly-slaughtered meats, as is reported by the Weser Zeitung, there was received, on the night of the 6th of the present month, a hog from Nieder-Löhme, which bore the official stamp, "Inspected," signed "Schaubez," and which was found to be swarming with trichinæ. It was accordingly seized by the police. The examination which was then made at the inspection station had the following result: In 15 of the 24 fields of the compressor were found 32 trichinæ; in one field, 8 or more. At the further inspection which took place at the inspector's office in the central abattoir there were found in the same 24 fields 66 trichinæ.

From these revelations it can be plainly seen that the inspection of slaughtered hogs at Nieder-Löhme is very carelessly performed. These trichinæ were all alive, and in a condition for further development; so that, if that meat had gone into consumption, it would have entailed the greatest danger to consumers.

In consideration of the recent occurrences at Mühl-Rödlitz and Altona, where there have been severe outbreaks of trichinosis, the curator of the central cattle market has immediately notified the chief official at Nieder-Löhme of the above facts, and has demanded the immediate dismissal of the negligent inspector. It can be safely assumed that the meat in question had not been inspected at all.

November 11.—A professor of hygiene at one of the German universities writes to us as follows: "Allow me to call the attention of the honored editor of the Frankfurter Zeitung to the fact that in the controversy which has apparently broken out again about the deleteriousness of American pork, that it is the duty of the press to prevent alarm from spreading further among the people, and to point out again that according to all experience we have had so far, the trichinæ in American meat does not reach Europe in a live condition. The forming of pond-like bodies of water, through strong smoking or salting, kills the animals in a short time, and therefore there has been hitherto not a single known case of trichinæ caused by the use of that kind of meat, not even in the countries where no embargo ever existed, and where for a long period large quantities of American meats have been used, as, for instance, in England and Holland. The German, not the American, trichinæ is dangerous. The animals killed here are eaten fresh, without preparation, and the notorious rigid inspection is in no way competent to decide with certainty whether trichinæ exist or not, as the epidemic in Mühl-Rädlitz and still later in Altona fully demonstrate. The use of trichinous American meat is not attended with danger. Against the danger with which the use of the German pork under like circumstances is attended, there is but one certain preventive measure, and this the hygienic authorities should lose no time in recommending, viz, complete abstinence from the use of raw pork (sausage, etc.), and to have it regularly boiled or roasted before being eaten."

November 7.—The royal district physician in Düsseldorf, Dr. Zimmerman, announces officially that, out of 688 pieces of American bacon which were inspected

there on the 29th, 30th, and 31st of October, 12 pieces were found to contain trichinæ, some of them in great numbers. The Düsseldorf Daily Anzeiger, to which this information was communicated, comments thereon as follows:

"To the above we reply that we do not question the fact that trichinæ were found in the American meats which were presented for inspection; neither have we any reason to doubt a fact which has been officially communicated to us. What we do doubt, however, and what remains still, notwithstanding the official declaration of the district physician, an open question, is this: whether or not these sides of American bacon have really undergone the official American inspection. Upon this point hangs the whole public interest in the case; not alone for Düsseldorf and its vicinity, but for the whole of Germany. Since the officials have taken the trouble to make the above announcement, it is highly desirable that they should complete their declaration by informing the public under what precise conditions this circumstance has occurred; whether in fact the legally established precautions against trichinæ really protect the public, or whether some if not all of the Düsseldorf bacon had not previously passed our frontier in an irregular manner, and whether the trouble is not due to the negligence of our own customs officers."

We agree entirely with this view of the case. Instances have been reported to us in which the attempt has been made, through ignorance, to import shipments of bacon across the German frontier without proper certificates of inspection. These attempts have undoubtedly succeeded at certain frontier custom houses. At all events, these alleged cases of trichinæ require to be fully substantiated. The mayor of Duisburg makes an official announcement in respect to this case, which had been formally reported to him, in which he gives notice that the police authorities are authorized and required to demand a reinspection of all imported pork before it is offered for public sale. All persons who wish to sell such meats should report them to the local meat inspectors, to be reinspected and restamped. Refusal to comply with this regulation should be severely punished. That which is prescribed in Duisburg should be enforced in other localities throughout Germany. Moreover, it would be much better if the Government would, at least provisionally, require the reinspection of all incoming American meats at our ports of entry, where complete facilities could be provided and the inspection carefully made without further trouble to the public or to local officials. The extension of the regulation announced by the mayor of Duisburg to all imported meats (not merley to American pork) would seem to be, at all events, somewhat too far reaching. The Government would do well to take the matter energetically in hand, if it does not wish this crusade against American trichinæ to be converted into a formal opposition to its system of political economy. Good laws are often discredited through maladministration; this danger appears to us to be also involved in the Imperial decree of the 3d September.

A press dispatch from Berlin, under date of December 12, says:

Dr. Braekbusch, the noted scientist, has made public the results of examinations of 3,000 specimens of American pork. Dr. Braekbusch found traces of trichinæ in about 2½ per cent of the specimens which passed through his hands. He experimented with cats and dogs, trying to infect them by feeding them with the diseased meat, but failed entirely. This the doctor considers positive proof that the trichinæ survive only a short time after the death of the infected animal. He holds that American pork, even of poor quality, is perfectly harmless when it reaches Germany.

This conclusion as to the destruction of trichinæ by the curing process is confirmed by all of the examinations and experiments which have been made in Germany and France. A considerable amount of evidence proving the innocuousness of the trichinæ-infected pork that had been properly salted was collected by the writer and published in the report of the commission which was appointed by President Arthur to investigate this matter, in 1883, and there have been absolutely no investigations made since which throw any doubt upon the conclusion reached at that time. The statement that Dr. Braekbusch found traces of trichinæ in 2½ per cent of the specimens which passed through his hands, if correct, shows very conclusively that he examined pork which had not been inspected before shipment from this country, as this is a larger percentage than exists in the average of hogs as they are examined here at time of slaughter.

By the system of inspection which is now enforced in this country, the inspected meats can be guaranteed as in every respect equal or

superior to the meats inspected in any other country. The inspectors have been selected for their competency, a rigid discipline is maintained, and the inspection is from every point of view thorough and satisfactory. In addition to this, the people of the United States are more opposed to the use of the carcasses of animals affected with any form of disease than are the people of any other country, and for that reason animals are condemned here which would be freely passed for consumption abroad. Any objections raised to our inspected meats are, therefore, the result of hostility to our trade, and are in the highest degree unfair and unjust.

INTERNATIONAL CONGRESSES.

By authority and direction of the Secretary of Agriculture, the chief of the Bureau of Animal Industry attended, as the delegate of the Department of Agriculture, the International Congress of Hygiene and Demography, held in London, August 10-17, and the International Congress of Agriculture, held at The Hague, September 7-12. It affords me great pleasure to report that the representative of the Department received from both of these important bodies the most marked attention and very flattering evidences of their consideration. He was elected an honorary vice-president and member of the Foreign Council of section 3 of the Congress of Hygiene, which considered, during its sessions, the subject of the "Relations of the Diseases of Animals to those of Man." He was elected first vice-president of The Hague Congress, and also made a member of the Permanent Commission of the International Congress of Agriculture.

The importance and real value to the nation of the Department's being represented at such important deliberative assemblies can not be too highly appreciated. At both, questions were considered having the most direct bearing on our great export and import trade in food products; and at both there was occasion to explain the inspection service of this country and the care which is now being exercised here to prevent the shipment of animals affected with any contagious disease or of meats from animals in any way unsound.

The opportunity to become personally acquainted with the many distinguished delegates who represented the various countries of the world, some of them statesmen of great influence, and others scientists whose advice is sought by their governments, should be appreciated as one of the most important objects to be attained by representation at such gatherings. The spirit of friendliness and cordiality which pervaded all of the sessions indicates how favorably the relations of different countries may be modified by the personal contact of the men who, to so great an extent, influence the policy of their governments. The better these men become acquainted, the more they learn to appreciate each other's integrity and honesty of purpose, the fewer cases will there be of unjust regulations made by one country to injure the trade of another.

INSPECTION DIVISION.

On April 1, 1891, the force of the Bureau of Animal Industry was organized by order of the Secretary of Agriculture into four divisions, viz, the Inspection Division, the Division of Animal Pathology, the

Division of Field Investigations and Miscellaneous Work, and the Division of Quarantine. The different branches of the work will therefore be considered under the head of the division to which each belongs.

To the Inspection Division was assigned all work of an executive nature, including the eradication of contagious diseases, the inspection of export and import animals, meat inspection, vessel inspection, and the regulation of the movement of Southern cattle.

The only disease which the Bureau has attempted to eradicate up to this time is that known as

CONTAGIOUS PLEURO-PNEUMONIA.

During the past fiscal year the lines of work laid out at the commencement of the operations against pleuro-pneumonia have been closely followed. The success of the Bureau's plans of fighting this disease in the States of Illinois, Pennsylvania, and Maryland demonstrated that what in some other countries had proved a failure could be successfully carried out. During the year no instance of this disease has been reported from either of the three States in which the Bureau had carried on its operations, and which, as a result of these operations, had been cleared of the disease. The last case discovered in Maryland occurred in October, 1889, and while very careful watch has been kept over the slaughtering establishments in the city of Baltimore, no further cases of the disease have developed in that city, once a stronghold of pleuro-pneumonia.

Pennsylvania, likewise, has been free of disease, and the inspection of slaughterhouses, which has been continued since the removal of the quarantine, has revealed no cases of pleuro-pneumonia since the removal of the quarantine above referred to. It has been deemed advisable to maintain a careful watch and constant inspection at both the stock yards and slaughterhouses in Philadelphia, owing to their proximity to the State of New Jersey, which has not yet been declared free of disease. This is a safeguard or precautionary measure which will be continued until the final extirpation of this disease from the entire United States.

THE WORK IN NEW YORK.

The radical and stringent measures, both of disinfection and in the matter of the movement of animals on Long Island, adopted in the early part of last year, have been strictly adhered to in that district during the past fiscal year, and have proved, as expected, successful. The troubles incident to the opposition of interested parties in the infected area of Kings and Queens Counties were soon lessened. The vigorous measures adopted led the parties who had before obstructed the work of the Bureau and secretly nursed contagious pleuro-pneumonia wherever possible, in order to introduce it into herds for their own profit, to realize that the Department was in earnest in its efforts to eradicate the disease, and would punish all who violate the law and regulations.

The consequence has been that the disease no longer exists in these counties, and consequently the State of New York has at last been freed from this contagion. The last case discovered on Long Island was on April 30, 1891, and seven months have therefore elapsed without the development of any further cases of the disease. While the absence of contagious pleuro-pneumonia for a period of six months has been and is considered sufficient to demonstrate the freedom of a dis-

trict from the disease, and the Department would be fully warranted in removing its quarantine restrictions at this time, it is recommended, in view of the fact that the disease had existed for over fifty years in this district, that the quarantine regulations be maintained until April 30, 1892, a period of one year from the last appearance of disease.

From July 1, 1890, to June 30, 1891, there were inspected in New York 16,219 herds, containing 139,322 head of cattle; 134,464 animals were reëxamined, and 40,915 were tagged with numbered tags and registered upon the books of the Bureau. There were during this period ten new herds found infected with contagious pleuro-pneumonia, and these herds contained 172 animals, 40 of which animals were found to be diseased upon post-mortem. There were purchased for slaughter during the same time 35 affected cattle, at a cost of $1,016.63, an average of $29.05 per head; also 569 exposed cattle, at a cost of $13,846.05, an average of $24.33 per head. The smaller cost of the exposed cattle was due, as in previous years, to the fact that the amount which the owner realized for the carcasses was deducted from the appraised value, the Department paying the balance. One hundred and ninety-three stables and premises were disinfected during the year, and post-mortem examinations were made upon 10,003 head of cattle, of which 40 were found diseased with pleuro-pneumonia.

The total expenses in the State of New York for the past fiscal year were $105,960.19, of which $14,862.68 was paid for cattle purchased for slaughter as either diseased or exposed. The remainder of these expenses constitutes the cost of disinfection, inspection, tagging, registering, supervising the movement of cattle, post-mortem examinations, and all the various expenses incident to a work of this character.

THE WORK IN NEW JERSEY.

In this State the work of suppressing pleuro-pneumonia has been continued with special vigor and strict enforcement of the regulations of the Department. The district infected has been confined to the counties of Hudson and Essex, and while the number of herds found to be diseased have been few, they have been discovered at intervals so far apart as to have covered the fiscal year, and the time between the outbreaks has not been sufficient for us at any time to declare the disease completely eradicated. The great difficulty met with in handling pleuro-pneumonia in this State is due to the fact that the State of New Jersey has never coöperated by act of its legislature with the Bureau, nor given to the Bureau any authority to punish those who disregard the regulations of the Department. Under the State law the period of quarantine of premises in which diseased animals have been found is limited to thirty days. This is a length of time insufficient to protect new animals that may be brought upon the premises at its expiration, and this fact may account, in a large measure, for the continued existence of the disease in New Jersey. Within the past few months the Department has undertaken to itself enforce its regulations, independent of State coöperation, relying entirely upon the authority vested in it by the acts of Congress.

From July 1, 1890, to June 30, 1891, there have been inspected in New Jersey 7,697 herds, containing 61,230 head of cattle. Of this number 48,655 head were reëxamined, and 6,903 tagged with numbered tags and registered upon the books of the Bureau. Only four new herds were found affected with pleuro-pneumonia during the year, containing 53 animals, 12 of which were pronounced diseased at the time

the inspection was made. The total number of permits issued for the movement of cattle in this State was 1,329. There were purchased for slaughter during this period 12 head of affected cattle, at a cost of $382, and 67 exposed cattle, at a cost of $1,771.50. It was found necessary to disinfect but 13 premises and to make post-mortem examinations upon the carcasses of 6,208 animals, of which number only 12 were found diseased with pleuro-pneumonia.

The total expenses in New Jersey during the fiscal year 1891 were $42,913.37, of which $2,153.50 was paid for the purchase of cattle for slaughter because they were either diseased or had been exposed.

THE WORK IN MARYLAND.

The inspection of stock yards and slaughterhouses in Baltimore County, State of Maryland, was continued as a matter of precaution during the fiscal year. During this time 752 herds, containing 64,758 animals, were inspected, and 3,115 post-mortem examinations made. No disease was found during the fiscal year ending June 30, 1891, nor has any been found since that time. Two years have therefore elapsed since the discovery of any pleuro-pneumonia in the State of Maryland, and there can be no question that this State is now and will be for all time to come free from contagious pleuro-pneumonia, unless the contagion is again introduced by the importation of affected cattle.

THE WORK IN PENNSYLVANIA.

During the past year 1,128 herds, containing 45,508 animals, were inspected in Philadelphia, and 26,750 post-mortem examinations made. As stated before, no contagious pleuro-pneumonia was found, and no cases have been found since.

THE WORK AS A WHOLE.

Including all the districts in which the Bureau has been carrying on its work of extirpating pleuro-pneumonia, as well as watching those districts from which it has eradicated this disease, there were inspected during the fiscal year ending June 30, 1891, a total of 25,796 herds, containing 310,818 animals. Of this number 183,119 animals were reëxamined and 47,818 were tagged with numbered tags and registered upon the books of the Bureau.

The following table gives a résumé of this work, as given in detail above:

	New York.	New Jersey.	Maryland.	Pennsylvania.	Total.
Herds inspected	16,219	7,697	752	1,128	25,796
Cattle inspected	139,322	61,230	64,758	45,508	310,818
Cattle reëxamined	134,464	48,655			183,119
Post-mortem examinations	24,113	6,208	3,115	26,750	60,186
Diseased carcasses found	40	12			52
Cattle tagged	40,915	6,903			47,818
New herds found affected	10	4			14
Animals in affected herds	172	53			225
Diseased cattle purchased	35	12			47
Exposed cattle purchased	569	67			636
Premises disinfected	195	12			207

It may be interesting to note the number of diseased and exposed cattle which have been purchased and slaughtered each year since the

work for the eradication of pleuro-pneumonia was commenced, as shown by the following table:

	1886-'87.	1887-'88.	1888-'89.	1889-'90.	1890-'91.	Total.
Diseased	1,342	2,398	1,903	676	47	6,366
Exposed	1,576	5,345	4,583	3,033	636	15,178

MOVEMENT OF SOUTHERN CATTLE.

The mildness of last winter made it necessary to commence the control of Southern cattle coming to Northern markets at an earlier period than for the preceding year, and on February 5, 1891, the necessary order regulating the movement of cattle in this branch of our interstate commerce was issued as follows:

REGULATIONS CONCERNING CATTLE TRANSPORTATION.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., February 5, 1891.

To the managers and agents of railroad and transportation companies of the United States, stockmen, and others:

In accordance with section 7 of the act of Congress approved May 29, 1884, entitled "An act for the establishment of a Bureau of Animal Industry, to prevent the exportation of diseased cattle, and to provide means for the suppression and extirpation of pleuro-pneumonia and other contagious diseases among domestic animals," and of the act of Congress approved July 14, 1890, making appropriation for the Department of Agriculture for the fiscal year ending June 30, 1891, you are hereby notified that a contagious and infectious disease known as splenetic or Southern fever exists among cattle in the following-described area of the United States:

All that country lying east and south of a line commencing at the southeast corner of the Territory of New Mexico; thence running northerly along the eastern boundary of New Mexico to the southwestern corner of the county of Cochran, State of Texas; thence easterly along the southern boundaries of the counties of Cochran, Hockley, Lubbock, Crosby, Dickens, and King to the one hundredth meridian of longitude; thence northerly along said one hundredth meridian to the southern boundary of the State of Kansas; thence easterly along the southern boundary of the State of Kansas to the northeast corner of the Indian Territory; thence southerly along the eastern boundary of the Indian Territory to the southwestern corner of the State of Missouri; thence easterly along the southern boundaries of the State of Missouri and the State of Kentucky and the State of Virginia to a point where said boundary is intersected by the Blue Ridge Mountains; thence in a northeasterly direction, following said Blue Ridge Mountains, to the southwestern corner of the county of Madison, State of Virginia; thence easterly along the southern boundaries of the counties of Madison, Culpeper, and Stafford; thence northerly along the eastern boundary of Stafford County to the Potomac River; thence, following the Potomac River, southerly to the Chesapeake Bay; thence easterly along the southern boundary of Maryland to the Atlantic Ocean.

From the fifteenth day of February to the first day of December, 1891, no cattle are to be transported from said area to any portion of the United States north or west of the above-described line, except in accordance with the following regulations:

(1) When any cattle in course of transportation from said area are unloaded north or west of this line to be fed or watered, the places where said cattle are to be so fed or watered shall be set apart, and no other cattle shall be admitted thereto.

(2) On unloading said cattle at their points of destination, pens shall be set apart to receive them, and no other cattle shall be admitted to said pens; and the regulations relating to the movement of Texas cattle, prescribed by the cattle sanitary officers of the State where unloaded, shall be carefully observed. The cars that have carried said stock shall be cleansed and disinfected before they are again used to transport, store, or shelter animals or merchandise.

(3) Whenever any cattle that have come from said area shall be reshipped from any of the points at which they have been unloaded to other points of destination,

the car carrying said animals shall bear a placard stating that said car contains Southern cattle, and each of the waybills of said shipment shall have a note upon its face with a similar statement. At whatever point these cattle are unloaded they shall be placed in separate pens, to which no other cattle shall be admitted.

(4) The cars used to transport such animals and the pens in which they are fed and watered, and the pens set apart for their reception at points of destination, shall be disinfected in the following manner:

(*a*) Remove all litter and manure. This litter and manure may be disinfected by mixing it with lime, diluted sulphuric acid, or, if not disinfected, it may be stored where no cattle can come in contact with it until after December 1.

(*b*) Wash the cars and the feeding and watering troughs with water until clean.

(*c*) Saturate the walls and floors of the cars and the fencing, troughs, and shutes of the pens with a solution made by dissolving four ounces of chloride of lime to each gallon of water. Or disinfect the cars with a jet of steam under a pressure of not less than 50 pounds to the square inch.

The losses resulting yearly to the owners of susceptible cattle, both in the interstate and export trade, by the contraction of this disease from exposure in unclean and infected cars and pens, and by means of the manure carried in unclean cars from place to place, and the threatened prohibition of our export trade by foreign governments because of the occurrence of this disease, have become a matter of grave and serious concern to the cattle industry of the United States. It is absolutely essential, therefore, that this cattle industry should be protected as far as possible by separating the dangerous cattle and by the adoption of efficient methods of disinfection.

A rigid compliance with the above regulations will insure comparative safety to Northern cattle and render it unnecessary to adopt a more stringent regulation, such as the absolute prohibition of the movement of Southern cattle except for slaughter during the time of year that this disease is fatal.

Inspectors will be instructed to see that disinfection is properly done, and it is hoped that transportation companies will promptly put in operation the above methods.

Very respectfully,

J. M. Rusk,
Secretary.

The quarantine line of the present year was extended from the Mississippi River east to the Atlantic Ocean, and it was endeavored as nearly as possible, and having some regard to the State lines, to follow the line of permanent infection previously established, and as published in the report of the Bureau of Animal Industry for the year 1884.

The system established by the regulations consisted in the separation of all cattle coming from south of this line at the first stock yards they entered, and the herding in separate pens, and the continuance of this inspection until they were finally slaughtered. All cars carrying this class of cattle were to be placarded with signs showing that they carried Southern cattle, and the waybills for these cars stamped with the words "From Southern fever district;" and all cars which transported this class of cattle were to be thoroughly cleaned and disinfected by the railroad companies before being again used for the transportation of cattle.

Some idea of the amount of work done by the Bureau in supervising the movement of Southern cattle may be had from the fact that 63,113 car loads, comprising 1,617,265 head of cattle, were inspected and kept separate and distinct during their transportation over the various railroads and through the different stock yards of the country.

It was not possible during the present season to maintain as rigid an inspection of the work of disinfecting cars, performed by the railroad companies, as was necessary to insure absolute safety in this traffic. The Department was compelled in a measure to rely upon the railroad companies for an observance of this part of the regulations and for the thoroughness of the work. While a large number of the railroad companies cheerfully complied with the regulations as to cleaning cars,

and endeavored to carry them out thoroughly, it is also true that others were careless in attending to this matter, while still others failed to observe these regulations at all. The consequence, therefore, has been that while the outbreaks of Texas or Southern fever have been greatly diminished during the present season, they have still appeared in various parts of the country, and cases have occurred among cattle in our export trade. This is due to the failure of some railroads to comply with the regulations as to cleaning cars, and their use of unclean cars for cattle transportation.

In the export trade there has been reported up to the present time a total of 524 head of cattle affected with Southern fever. These cattle were, for the most part, infected through unclean cars, and it became necessary for the Department to schedule one railroad, which had failed to comply with the regulations, against the carrying of export cattle, and to issue positive instructions to our inspectors at interior yards that no cattle should be tagged or export granted unless the cars supplied by the railroads for their transportation were cleaned and disinfected immediately prior to their loading.

It is necessary that Congress enact some legislation to compel railroad companies to comply with the regulations for cleaning and disinfecting cars that have carried Southern cattle before this disease can be entirely prevented. At present there is no penalty or provision of law by which railroad companies can be held to a strict compliance with this rule, and the only means at the disposal of the Department is as regards export cattle, for which certificates of clearance may be refused if this rule is not complied with.

In the early part of the season urgent requests were made by the State authorities of Colorado and Wyoming that the Department permit cattle from south of its line to go into said States for grazing purposes. The line of inspection as established by these two States was considerably farther south than the line adopted by the Department, and it was claimed by them that their line was absolutely safe, and that they would assume all responsibility for any disease that might be taken into their States by the cattle shipped from this disputed area. For reasons which seemed at the time to possess sufficient weight, this request was granted, and cattle were allowed to go from the area of country between the two lines to Colorado and Wyoming for grazing purposes, but upon condition that the same should be transported by rail and not allowed to cross ranges or trails of other cattle, nor be shipped to market until after December 1, 1891, as stated in the following order:

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., April 23, 1891.

Notice is hereby given that cattle which have been at least ninety days in the area of country hereinafter described may be moved from said area by rail into the States of Colorado, Wyoming, and Montana, for grazing purposes, in accordance with the regulations made by said States for the admission of Southern cattle thereto: *Provided,* (1) That cattle from said area shall go into said States only for slaughter or grazing, and shall on no account be shipped from said States into any other State or Territory of the United States before the 1st day of December, 1891.

(2) That such cattle shall not be allowed in pens or on trails or ranges that are to be occupied or crossed by cattle going to the Eastern markets before December 1, 1891, and that these two classes of cattle shall not be allowed to come in contact.

(3) That all cars which have carried cattle from said area shall, upon unloading, at once be cleaned and disinfected in the manner provided by the regulations of this Department of February 5, 1891.

(4) That the State authorities of the States of Colorado, Wyoming, and Montana agree to enforce these provisions.

The area from which cattle may go into the States of Colorado, Wyoming, and

Montana by rail for grazing, as above provided, is as follows: All that area included within the following boundary lines, viz: Commencing at the southeast corner of the Territory of New Mexico; thence running northerly along the eastern boundary of New Mexico to the southwestern corner of the county of Cochran, State of Texas; thence easterly along the southern boundaries of the counties of Cochran, Hockley, Lubbock, Crosby, Dickens, and King, to the one hundredth meridian; thence northerly along said one hundredth meridian to the Red River, where it crosses the eastern boundary of the county of Childress; thence following said Red River to the northwest corner of the county of Wichita; thence along the eastern boundaries of the counties of Wilbarger, Baylor, Throckmorton, and Shackleford; thence west along the southern boundary of Shackleford County; thence south along the eastern boundaries of Taylor, Ronnels, Concho, Menard, and Kimble counties; thence west along the south lines of Kimble, Sutton, and Crockett counties; thence south along the east line of Pecos County to the Rio Grande River; thence along the Rio Grande River to the one hundredth meridian, and thence northerly along said meridian to the point of beginning.

J. M. RUSK,
Secretary.

It transpired that, notwithstanding the representations made by the authorities of these two States, cattle shipped from south of the Department's line and north of their line disseminated Texas fever in both Colorado and Wyoming, and there were considerable losses among the native cattle of these two States by infection from the Southern cattle introduced under this arrangement. It appears, therefore, that the line adopted by the Department can not be materially changed without grave danger to the cattle industry.

INSPECTION OF EXPORT ANIMALS.

This work has been continued under the provisions of the act of Congress of August 30, 1890, and covers the inspection of animals at interior stock yards, the tagging of animals at these points with numbered metal tags, and the collection and recording of a history of the animals at the time of tagging, the reinspection of these animals at the port of export, and the loading of the same on board vessels.

The following tables show the details of this work for the fiscal year ending June 30, 1891:

Statement showing number of animals tagged and inspected for export from the commencement of such work, November 15, 1890, to close of the fiscal year 1891.

Place.	Export cattle tagged.		Total.	Export cattle inspected.		Total.	Cattle rejected on inspection on account of disease.	Export sheep inspected Jan. 1 to June 30, 1891.
	Nov. 15 to Dec. 31, 1890.	Jan. 1 to June 30, 1891.		Nov. 15 to Dec. 31, 1890.	Jan. 1 to June 30, 1891.			
New York, N. Y	9,844	10,781	20,625	19,368	57,769	77,137	50	7,447
Boston, Mass	6,143	17,771	23,914	15,620	48,231	63,851	30	1,529
Portland, Me	3	3	6	412	1,797	2,209	1	....
Baltimore, Md	10,589	11,761	22,350	11,639	33,513	45,152	4	1,643
Newport News, Va	1,950	7	1,957	2,890	1,831	4,721	1	....
West Point, Va	499	1	500	541	350	891	0	....
Norfolk, Va	337	....	337	337	325	662	0	....
Philadelphia, Pa	801	1,170	1,971	1,284	6,561	7,845	0	709
New Orleans, La	....	250	250	....	250	250	0	....
Chicago, Ill	18,643	103,463	122,106	18,643	103,463	122,106	78	10,486
Buffalo, N. Y	4,501	4,784	9,285	4,501	15,114	19,615	7	....
Pittsburg, Pa	18	384	402	2,918	12,081	14,999	0	....
Aggregate	53,328	150,375	203,703	78,153	281,285	359,438	171	21,814

Statement showing exports of domestic cattle to Europe during the fiscal year ending June 30, 1891.

Port of export.	Great Britain.	Germany.	Belgium.	France.	Total.
First half—six months ending December 31, 1890.					
New York, N. Y	83,411	1,390	3,009	3,223	91,033
Boston, Mass	58,727	137	802		59,666
Baltimore, Md	40,985	368	1,602	703	43,658
Philadelphia, Pa	7,982				7,982
New Orleans, La	189				189
Portland, Me	412				412
Norfolk, Va	686				686
Newport News, Va	5,616	185	352	1,327	7,480
West Point, Va	1,496				1,496
Aggregate	199,504	2,080	5,765	5,253	212,602
Second half—six months ending June 30, 1891.					
New York, N. Y	53,552	2,539	552	299	56,942
Boston, Mass	47,871	360			48,231
Baltimore, Md	32,376	539	265	333	33,513
Philadelphia, Pa	6,561				6,561
New Orleans, La	250				250
Portland, Me	1,797				1,797
Norfolk, Va	325				325
Newport News, Va	1,831				1,831
West Point, Va	350				350
Aggregate	144,913	3,438	817	632	149,800
Aggregate, fiscal year 1891	344,417	5,518	6,582	5,885	362,402

The exports of cattle for the fiscal year ending June 30, 1891, show a decrease of $3\frac{3}{4}$ per cent compared with the exports for the fiscal year ending June 30, 1890. The total exports for 1891 amounted to 362,402, as against 372,690 for the preceding fiscal year. The cause of this decrease in exports is undoubtedly due to the increase in prices of cattle in this country during the latter part of the fiscal year, cattle bringing in June, 1891, from $1.25 to $1.50 per 100 pounds more than in June, 1890.

INSPECTION OF IMPORTED ANIMALS.

The act of August 30, 1890, provides for the inspection of all imported cattle, sheep, and swine arriving in the United States. This work was inaugurated by the Bureau immediately after the passage of the act, and has been continued in accordance with its regulations. Inspection stations have been established along the Canadian border, and the three quarantine stations along the Atlantic seaboard, which were already in existence, have been maintained under the direction of the quarantine division. At the commencement of this work stations were established along the Mexican border, but since the provisions of the present tariff law went into effect no importations of cattle, sheep, or swine have been made from Mexico, and for this reason these stations were discontinued. The total number of animals inspected to June 30, 1891, imported at our Canadian stations, were 2,218 cattle, 44,948 sheep, and 29 swine. At the quarantine stations on the Atlantic seaboard there were imported and quarantined for ninety days 45 cattle, imported for breeding purposes; also 776 sheep and 70 swine quarantined for fifteen days.

Owing to the failure of the Dominion of Canada to provide for the quarantine of sheep arriving in that country from countries infected with foot-and-mouth disease, the Secretary of Agriculture, on May 19,

1891, issued an order quarantining all sheep and swine imported from Canada into the United States for a period of fifteen days, as follows:

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., May 19, 1891.

Whereas under the act of Congress approved August 30, 1890, it has been provided by the Department of Agriculture, in order to protect the sheep and swine of the United States from contagious diseases now existing in foreign countries, that all sheep and swine imported from Great Britain and the continent of Europe must be held in quarantine for a period of not less than fifteen days; and

Whereas the Dominion of Canada makes no requirement of quarantine for sheep and swine imported into that country from Great Britain or the continent of Europe; and

Whereas to permit importations of these animals from Canada into the United States without quarantine would be dangerous to the stock interests of the United States, owing to the failure on the part of the Canadian authorities to enforce this measure of protection, and would enable importers to evade the quarantine at United States ports: Therefore, it is

Ordered, That all sheep or swine to be imported from Canada into the United States are hereby made subject to the regulations of the Department of Agriculture of date October 13, 1890, and the exception contained in the third and sixth regulations of said date, as applicable to Canadian sheep and swine, is hereby rescinded, and all animals named in said regulations, except cattle imported from Canada, are subject to the same conditions and requirements as if they were imported into the United States from Great Britain or the continent of Europe.

J. M. RUSK,
Secretary.

Some time thereafter the Dominion of Canada, by an order of council, established a quarantine of fifteen days on all sheep and swine imported into said Dominion from Great Britain or the continent ot Europe. As this quarantine of the Canadian Government corresponded with that adopted by the Department of Agriculture of the United States, the following order was issued on June 25, 1891, rescinding the order of May 19:

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., June 25, 1891.

Whereas on May 19, 1891, the Department of Agriculture, under the act of Congress approved August 30, 1890, issued an order providing that all sheep and swine to be imported from the Dominion of Canada into the United States should be subject to a quarantine of fifteen days at the port of entry, this order being issued upon the ground, as stated therein, that the Dominion of Canada had made no provision for a quarantine for sheep and swine imported into that country from Great Britain or the continent of Europe; and

Whereas the said Dominion of Canada, on the 6th day of June, 1891, by an order in Council, duly established a quarantine of fifteen days on all sheep and swine imported into said Dominion from Great Britain or the continent of Europe: Now, therefore, it is

Ordered, That the quarantine of sheep and swine imported from Canada into the United States, required by the aforesaid order of May, 1891, is hereby removed, and sheep and swine may be imported from Canada into the United States without quarantine: *Provided,* That on inspection of said sheep or swine at the ports of entry, they are found to be free of disease: *And provided further,* That sheep or swine imported into the United States from Great Britain or the continent of Europe through Canada shall have been held in quarantine by the Canadian Government for fifteen days, and the importer shall produce at the port of entry into the United States a certificate from the proper quarantine officer of said Government showing the fact of said quarantine.

J. M. RUSK,
Secretary.

The only contagious disease found among animals imported at our quarantine stations during the past year was among a shipment of 22 Southdown sheep from England, which entered at our quarantine

station at Garfield, N. J., and in which shipment were 11 animals affected with foot-rot. This shipment was detained in quarantine until the disease had entirely disappeared. The only other instance of disease occurred in a shipment of sheep from Canada, imported at Island Pond, Vt., in which were found five cases of foot-rot out of a shipment of 102 head. These were treated in the same manner as the sheep found diseased at the Garfield quarantine station.

The following tables show the results of the inspection of imported animals in detail:

Statement showing number of imported animals inspected by inspectors of the Bureau of Animal Industry from the commencement of inspections, November 15, 1890, to close of the fiscal year 1891.

Port of entry.	Nov. 15 to Dec. 31, 1890.			Jan. 1 to June 30, 1891.			Total.		
	Cattle.	Sheep.	Swine.	Cattle.	Sheep.	Swine.	Cattle.	Sheep.	Swine.
Portland, Me		102						102	
St. Albans, Vt				1,618			1,618		
Island Pond, Vt				383			383		
Newport, Vt				86			86		
Ogdensburg, N. Y		547		8	3	3	8	550	3
Cape Vincent, N. Y	1	1,080		7	43	3	8	1,123	3
Morristown, N. Y				6			6		
Buffalo, N. Y		23,210		6	19,058		6	42,268	
Suspension Bridge, N. Y				14	84	2	14	84	2
Detroit, Mich				24	58	4	24	58	4
Port Huron, Mich	3	168		62	573	17	65	741	17
Brownsville, Tex		22						22	
Aggregate	4	25,129		2,214	19,819	29	2,218	44,948	29

NOTE.—This statement does not include imported live stock received at the quarantine station located on the seaboard.

INSPECTION IN GREAT BRITAIN.

The inspection by American veterinarians of American cattle landed at the foreign animal wharves in Great Britain has been continued during the present year. It had been frequently alleged by the British Government that our cattle arriving in that country were affected with contagious pleuro-pneumonia, and their inspectors were continually reporting the arrival of diseased animals. The last report of the chief veterinary surgeon of Great Britain, for example, states that 14 animals from America had been found affected with contagious pleuro-pneumonia during 1890.

To ascertain upon what foundation these allegations were based, the Department established this transatlantic inspection in August, 1890. During its continuance but three cases of alleged pleuro-pneumonia have been reported by the British inspectors. The report of the American inspectors on those cases was to the effect that the disease was not contagious pleuro-pneumonia, but a form of interstitial pneumonia; and a consideration of all the facts, together with an examination of portions of the lungs forwarded to the Department by our inspectors, satisfied the chief of the Bureau of Animal Industry that the claim of the British authorities could not be maintained. The position taken by the American inspectors was confirmed by Prof. Williams, principal of the new Veterinary College, Edinburgh, one of the most eminent veterinarians in the profession, as well as by his son, a professor in the same institution, and by Dr. J. E. Ryder, member of the American Veterinary College, who was in England at the time. As the history of animals

alleged to be affected with this disease is of the greatest importance in reaching a correct diagnosis, every effort was made to obtain this in the most complete and reliable form. The animals claimed to have been affected were tagged in this country prior to their export, and the names of the owners, feeders, and the locality from which they came were recorded in the books kept by the Bureau. Obtaining, therefore, the tag numbers of these animals from our inspector abroad, we were enabled to make a careful examination of their history and trace them back to the farms on which they were reared. The result of this investigation demonstrated clearly that there had not been any disease of this character in the locality or neighborhood from which these animals came, nor on the farms upon which they were born and reared; nor had there been any possibility of exposure to the disease in course of transportation to the port of export. This history, in connection with the diagnosis of our inspectors, clearly established the fact that the claim made by the British authorities could not possibly be maintained.

In this connection it might be well to observe that these cases, and other cases of alleged pleuro-pneumonia claimed to have been found by the British authorities, occurred during the winter and spring months, at a time when cattle in the course of transportation across the Atlantic were exposed to storms and severe cold weather, tending to develop lung trouble and pneumonia in other forms than that of a contagious character. It is, therefore, safe to conclude that all the alleged cases of this disease said to have been found by the British veterinarians among American cattle were simply forms of pneumonia caused by the exposure incident to a voyage across the Atlantic during a cold and stormy period of the year.

The total number of animals inspected by our veterinarians stationed in Great Britain from the time of their commencement of work to June 30, 1891, was 289,745 head of catttle and 6,989 sheep. The following table shows the work of inspection at British ports for the fiscal year ending June 30, 1891:

Statement showing losses at sea and number of domestic cattle and sheep inspected by the inspectors of the Bureau of Animal Industry at London, Liverpool, and Glasgow from the commencement of inspections at those ports, August 16, 1890, to June 30, 1891.

Port.	Cattle.						Sheep.	
	August 16 to December 31, 1890.		Six months ending June 30, 1891.		Total.		May 1 to June 30, 1891.	
	Inspected.	Loss at sea.	Inspected.	Loss at sea.	Inspected.	Loss at sea.	Inspected.	Loss at sea.
London	57, 874	1, 742	60, 466	877	118, 340	2, 619	2, 149	30
Liverpool	71, 339	527	69, 518	551	140, 857	1, 078	3, 397	90
Glasgow	14, 859	498	15, 689	548	30, 548	1, 046	1, 443	1
Aggregate	144, 072	2, 767	145, 673	1, 976	289, 745	4, 743	6, 989	121

Aggregate loss: Cattle, $1\frac{3}{5}$ per cent; sheep, $1\frac{7}{10}$ per cent.

VESSEL INSPECTION.

Under the act of March 3, 1891, this Department was empowered to regulate the fittings of vessels carrying export cattle from the United States to foreign countries, and on June 6, 1891, the following regulations, designed to promote the better carrying of cattle, the more humane treatment of the same, and to insure their arrival at points of destination in better condition, were promulgated:

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., June 6, 1891.

Pursuant to the authority invested in the Secretary of Agriculture by virtue of an act of Congress approved March 3, 1891, entitled "An act to provide for the safe transport and humane treatment of export cattle from the United States to foreign countries, and for other purposes," the following regulations are hereby prescribed for vessels engaged in the transportation of cattle from the United States to foreign countries:

(1) The owners, agents, or master of any vessel desiring to transport cattle from any port of the United States will make application to the Secretary of Agriculture at Washington, D. C., for a certificate of register. Said application shall be made upon a blank form furnished by the Department of Agriculture to be filled out by the applicant, and on receipt of the same the Secretary of Agriculture will direct the veterinary inspector in charge of the port from which said vessel is to clear to examine said vessel, and if the same has complied with the regulations hereinafter prescribed a certificate of registry will be issued, good for the term of one year, which will entitle said vessel to engage in the trade of carrying export cattle, and will state the number of cattle which said vessel may transport: *Provided, however,* That any certificate of registry issued shall be subject at any time to cancellation upon the violation of any of these regulations by said vessel, and that the veterinary inspector of the port may from time to time make such changes in the fittings of said vessel as in his judgment may seem necessary.

SPACE.

(2) Cattle carried on the upper or spar deck must be allowed a space of 2 feet 6 inches in width by 8 feet in depth per head. No more than 4 head of cattle will be allowed in each pen. Cattle loaded between decks must be allowed a space of 2 feet 8 inches in width by 8 feet in depth, no more than 4 head being allowed in each pen, except at the end of a row, where 5 may be allowed together.

(3) Vessels will be allowed to carry three deck loads of cattle, but where it is desired to carry cattle on the lower or steerage deck special permission must be obtained from the inspector, which will only be granted in cases where said deck is provided with sufficient ventilation, as hereinafter prescribed.

UPPER-DECK FITTINGS.

(4) *Stanchions, wooden.*—Stanchions must be of good sound timber, 4 by 6 inches, placed at proper distances from centers, against ship's rail and inside stanchions, in their proper place directly in line with outboard stanchions, to be set up so that the 6-inch way of the stanchion shall set fore and aft. A proper tenon shall be cut on the head of same to receive the thwart-ship beam; the tenon not to be less than 3 inches in length and the shoulder not less than 2¼ inches on each side of the stanchion, thus leaving the tenon 1½ inches thick. A piece of 2 by 3 inches or 2-inch plank shall be fastened to outside of stanchion and run up to underneath rail to chock stanchion down and prevent lifting when beam is sprung to crown of deck. Open-rail ships shall be blocked out on backs of stanchions fair with the outside of rails to receive the outside of planking. Where upper-deck fittings are not permanent, the heels of outside stanchions shall be secured by a bracing of 2 by 3 inch sound lumber from the back of each stanchion to shear-streak or waterway, the heels of inside stanchions being properly braced from and to each other. Bulwark stanchions must also be extra stanchioned by raking shores running diagonally from the top of the stanchions to the deck.

Stanchions, iron.—These may be used in place of wooden stanchions, and should be not less than 2 inches in diameter, set in iron sockets above and below and fastened with nut and bolt.

Hook bolts or clamps.—Hook bolts or clamps must be made of ⅝-inch wrought iron, with hook on outboard end and thread and nut on inboard end, to pass over and under rail and through outboard stanchion and set up on the inside of same with a nut. These bolts may be double or single. If double then no thread or nut is necessary, but the stanchion will lie shipped through it, thus double hooking the rails. This will be found very useful where funnels or other deck fittings come in the way of beams passing from side to side of ship.

Beams.—Beams must be of good sound lumber, 3 by 6 inch, to run clear across the ship beam where practicable. Should any house or deck fittings be in the way, then butt up closely to same. These beams shall have a 1½ by 4 inch mortise cut in to receive the tenon of each and every stanchion, and to take the same crown as deck of ship by springing down to shoulder of outside stanchions, and to be properly

pinned or nailed to tenon and wedged tightly afterwards. The mortises shall be cut not less than 6 inches from outside ends of beams and a piece nailed on outside of same, and trimmed off fair with beam ends to prevent splitting.

Diagonal braces from stanchions to beams.—Diagonal braces shall be fastened on each stanchion on both sides of same, running up to top side of beam and properly secured by well nailing to both stanchion and beam.

Headboards.—Headboards shall be not less than 2 by 10 or 3 by 8 inches, of good sound lumber, and secured to every stanchion by ⅝-inch screw bolts passing through same and set up on same with a nut. Where headboards butt on a stanchion a piece of 1½-inch pine lumber shall be placed over the butts, like a butt strap, the bolts to go through same and be set up with a nut on the stanchions. These headboards can be placed on either side of the stanchions. All headboards shall have 1¼-inch holes bored through them at proper distance to tie the animals.

Footboards.—Footboards shall be of the same material as headboards, properly nailed or bolted to stanchions on the inside of same.

Division boards.—Division boards shall be of 2-inch sound lumber, fitted so as to be removable at any time, and so arranged as to divide the animals into lots of four, thus making compartments for this number all over the vessel. These division boards may be fitted perpendicularly or horizontally.

Flooring.—Flooring shall be of 1-inch boards, laid fore and aft on ships with wooden decks at the option of the owners. Iron-decked ships shall be sheathed with 2-inch spruce, hemlock, or yellow pine, or with 1-inch hemlock; but if 1-inch hemlock is used then the foot locks shall be 3 by 4 inches, to be laid so that they will properly secure the 1-inch boards, thus preventing them from slipping and at the same time acting as foot locks by showing a surface of 2 by 4 inches to correspond with the 2 by 3 inches. It is optional with the owners whether they permit sheathing to be used on their ships with wooden decks, or whether they allow foot locks to be secured to the deck. But on iron decks it is absolutely necessary (if permanent foot locks are not down) to sheath them before putting down the foot locks, in order to fasten same. Cement can be used instead of wood sheathing, and foot locks molded in same.

Foot locks.—Foot locks shall be of good sound lumber, size 2 by 3 inches or 3 by 4 inches hemlock, laid fore and aft of ship, placed 12 inches, 14 inches, 2 feet 2 inches, and 14 inches apart, the first one distant 12 inches from inside of footboard, filled in athwart ships opposite each stanchion, properly secured to sheathing or deck, and secured by a batten to go over all from stanchion to stanchion. When troughs are used, foot locks will be placed 17, 16, 22, and 16 inches apart.

Outside planking.—All outside planking on open and closed railed ships must be properly laid fore and aft of ship and nailed to the backs of stanchions, as close as possible for the cold season, and for the warmer months the top-course planking shall be left off fore and aft of ship in order to allow a free circulation of air. Nothing less than 2-inch spruce or 1½-inch yellow pine is to be used for this purpose. There shall be placed over each seam of outside planking a 1 by 5 inch batten securely nailed thereto, which will help to exclude wind and water.

PLANKING OF SHELTER DECK, TO BE ERECTED ON SPAR-DECKED SHIPS.

The plank to be nailed on this deck is simply to shelter the cattle, and it should be laid with 1½-inch sound lumber.

PLANKING OF SHELTER DECK, TO BE ERECTED ON WELL-DECK SHIPS.

The plank to form the shelter deck on well-deck ships shall be laid with 2-inch sound lumber sufficient to cover cattle. This plank shall be laid as closely as possible and well nailed to the beams, thus making a good deck from which to work the ship's gear.

Nails.—No nails less than 20-penny shall be used in foot locks or where 2-inch material is used. Twelve-penny nails can be used in 1½-inch plank or under.

UNDER-DECK FITTINGS.

Stanchions.—Stanchions shall be of good sound lumber 4 by 6 inches, set up at proper distances from centers so that the 6-inch way of same shall stand fore and aft and jammed in tight between the two decks, properly braced on head and from side to side of ship; this bracing shall be of 2 by 3 inch spruce or yellow pine and be properly butted against each stanchion. Where it is found impracticable to run these braces across ship, by reason of hatches, etc., coming in the way, then they shall be well braced from hatch combings and from the obstruction which prevents running braces from side to side. The heads of these stanchions shall be braced fore and aft by 2 by 3 inch pieces well nailed on each stanchion and running fore and aft close up to the lower edge of the ship beams and butted at each end of compart-

ment and against themselves, or chocked in underneath beam and well nailed to heads of stanchions. If upper and lower decks are wood, then the stanchions set up between decks may be secured by well cleating to each deck at heads and heels of same.

Headboards.—Headboards shall be of the same dimensions as those on the upper deck, fastened in the same manner, with 1½-inch holes bored at right distances to tie animals.

Footboards.—Footboards shall be of same dimensions as those on upper deck, and fastened in the same manner.

Division boards.—Division boards shall be fitted perpendicularly or horizontally, and arranged so that they divide the animals into pens of 4, or, at end of row, into pens of 5, and shall ship or unship by forming a slide on cargo battens to head and foot boards or on stanchions.

Flooring.—Where ships have decks of wood it shall be optional with owners whether they have boards put down to protect decks, or whether they allow the foot locks to be nailed to the ship's deck. (Permanent foot locks may be put down.) If the decks are of iron then wooden flooring must be laid either of 2-inch spruce with 2 by 3 inch foot locks, or of 1-inch hemlock with 3 by 4 inch foot locks, same as provided for upper decks. Cement may also be used instead of wood flooring, molding the foot locks in their proper places between same.

Foot locks.—Foot locks may be put down any size over 2 by 3 inches, but nothing under this size shall be used. They should be laid fore and aft of ship at distances mentioned in upper-deck fittings, and be well fastened to either deck or flooring, or to themselves, and properly filled in athwart ships between stanchions, same as on upper deck.

Troughs.—Suitable troughs may be formed on the footboards about 12 inches wide, when required, by nailing footboard on outside of stanchion and fitting up on the inside.

Casing for steering gear.—A suitable casing must be placed over the ship's steering gear when found necessary.

Alleyways.—Alleyways between the pens must not be less than 18 inches, unless otherwise authorized by inspectors.

VENTILATION.

(5) Each compartment containing cattle must have at least four bell-mouthed ventilators of not less than 18 inches inside diameter and with tops exceeding 7 feet in height, two situated at each end of the compartment.

(6) Vessels desiring to carry cattle on third deck may obtain special permit from the inspector of the port, when said vessel is fitted same as second deck and properly ventilated.

(7) No cattle shall be loaded along the alleyways by engine room unless side of said engine room is covered by 1½-inch grooved and tongued lumber, making a 3-inch air space.

(8) No cattle shall be loaded on hatches on decks above cattle, nor shall any merchandise, freight, or food for cattle be loaded on said hatches, but said hatches shall at all times be kept clear.

(9) Only two days' feed for cattle, at the discretion of port inspectors, shall be allowed to be carried on deck, properly covered, and this must be the first feed used.

(10) All vessels will carry not less than four hogsheads of over 100 gallons capacity for each 100 head of cattle, and these shall be filled with fresh water before sailing and refilled as emptied.

(11) Vessels will require shippers to furnish a foreman to be in charge of cattle, and 1 cattleman for each 25 head of animals shipped. Three-fourths of the men in charge of a shipment of cattle must be experienced men who have made previous trips with cattle, and who must satisfy the veterinary inspector at the port, by satisfactory evidence, that they are capable and reliable. Shippers will notify the inspector of the port two days before the sailing of a vessel of the name of the foreman to be in charge of their shipment and of the names of the attendants, and the veterinary inspector will certify said men to the captain of the vessel if he has reason to believe they are reliable. The captain of the vessel will report to the veterinary inspector of the port on his return as to the conduct and efficiency of each of the men in charge of cattle on his previous trip, and such men as have been found to be unsuited to be in charge of cattle will thereafter be refused certification to go with any shipment of cattle by the inspector of the port.

(12) Cattle will be tied with ¾-inch rope, which shall not be used more than once.

(13) On vessels having false decks upon which cattle are loaded, these must be removed and the manure and dirt cleaned from underneath before receiving another cargo of cattle.

(14) No vessel will be allowed to take on board any cattle for export unless the

same have been at the port of embarkation at least twenty-four hours before the vessel sails, except in special cases and by direction of inspector.

(15) The inspector of the port may, in case he finds any of the fittings are worn, decayed, or appear to be unsound, require the same to be replaced before he clears the vessel. He will also supervise the loading of cattle and see that they are properly stowed and tied, and that all the requirements of these regulations have been complied with.

J. M. Rusk,
Secretary.

The various steamship companies engaged in this traffic have very cheerfully accepted these regulations, and, at some expense, have remodeled their vessels so as to comply with them. The result so far of the vessel inspection regulations has been to reduce losses from suffocation and weak fittings in vessels. The total number of vessels examined from July 1 to September 19, 1891, was 215, of which 98 sailed from the port of New York, 52 from the port of Boston, 42 from the port of Baltimore, 15 from the port of Philadelphia, and 8 from the port of Newport News.

MEAT INSPECTION.

The most important work of the Bureau, placed upon it by the act of Congress of March 3, 1891, is that of meat inspection; important not only in view of the vast amount of work necessary to carry the provisions of this law into operation, but from its effect upon the commerce of the nation and the health of our people. The act of Congress of August 30, 1890, provided for the inspection of salted pork and bacon. It was the intention of Congress in passing this measure to enact a law which would enable this Government to so certify to the wholesomeness of our pork products that it would entitle them to entry into foreign countries. The provisions of this act, however, referred more particularly to an inspection which would determine the character and manner in which these products were packed and their condition at time of shipment, and did not reach to the more important object of determining whether the animals from which they came were diseased or not at the time of slaughter. The consequence was that foreign governments refused to recognize such inspection or certificates issued thereunder as sufficient to warrant the removal of the prohibition which they had for many years maintained against American pork.

In prescribing, therefore, regulations under the act of March 3, 1891, provision was made for a microscopic examination of hogs at time of slaughter, in order to certify that the same were free of the animal parasite called *trichinæ spiralis.* In addition to the provisions for microscopic inspection of pork, the regulations provided for an examination at time of slaughter by veterinary surgeons of all animals slaughtered for export or interstate trade, the condemnation of animals found to be diseased, and the proper identification of carcasses and the products of the same which entered into these two classes of our commerce.

The regulations governing the work of meat inspection are as follows:

U. S. Department of Agriculture,
Office of the Secretary,
Washington, D. C., March 25, 1891.

The following rules and regulations, being additional to the rules and regulations heretofore made under the act of Congress approved August 30, 1890, are hereby prescribed for the inspection of live cattle, hogs, and their carcasses, by virtue of the authority conferred upon the Secretary of Agriculture under the provisions of

the act of Congress approved March 3, 1891, entitled "An act to provide for the inspection of live cattle, hogs, and the carcasses and products thereof which are the subjects of interstate commerce, and for other purposes."

EXPORT CATTLE INSPECTION.

(1) The order and regulations providing for the inspection of export cattle and sheep, made October 20, 1890, under the provisions of section 10 of the act of Congress approved August 30, 1890, are hereby continued in full force and effect, the same as if made under the provisions of the act of March 3, 1891, and all exporters, to secure clearance for their shipments of cattle, must comply strictly with the said regulations.

MEAT INSPECTION.

(2) The proprietors of slaughterhouses, canning, salting, packing, or rendering establishments, engaged in the slaughter of cattle, sheep, or swine, the carcasses or products of which are to become subjects of interstate or foreign commerce, will make application to the Secretary of Agriculture for inspection of said animals and their products.

(3) The said application must be in writing, addressed to the Secretary of Agriculture, Washington, D. C., and shall state the location and address of the slaughterhouse or other establishment, the kind of animals slaughtered, the estimated number of animals slaughtered per week, and the character and quantity of the products to go into interstate or foreign commerce from said establishment; and the said applicant in his application shall agree to conform strictly with all regulations or orders that may be made by the Secretary of Agriculture for carrying on the work of inspection at such establishment.

(4) The Secretary of Agriculture, upon receipt of said application and after consideration thereof, will give said establishment an official number, by which all its inspected products will thereafter be known, and this number will be used both by the inspectors of the Department of Agriculture and by the owners of said establishment to mark the products of the establishment, as hereinafter prescribed.

(5) The Secretary of Agriculture will appoint and designate a veterinary inspector to take charge of the examination and inspection of animals and their products for each establishment which has been officially numbered, as prescribed by Rule 3, and will detail to such inspector such assistants or other employés as may be necessary to properly carry on the work of inspection at such establishment. The inspector appointed, and all employés under his direction, shall have full and free access at all times to all parts of the building or buildings used in the slaughter of live animals and the conversion of their carcasses into food products.

(6) The veterinary inspector in charge of said establishment will carefully inspect all animals in the pens of said establishment about to be slaughtered, and no animal shall be allowed to pass to the slaughtering room until it has been so inspected. Whenever any animal is found on said inspection to be diseased, said animal shall thereupon be condemned by the inspector, and the owner of the same shall at once remove it from the premises and dispose of it in such manner as may be provided by the laws of the State in which said animal is located.

(7) The veterinary inspector or his assistant shall carefully inspect at time of slaughter all animals slaughtered at said establishment and make a post-mortem report of the same to the Department. Should the carcass of any animal, on said post-mortem examination, be found to be diseased and unfit for human food, the said carcass shall at once be removed from said establishment under the supervision of the inspector and be disposed of in the manner provided by the laws of the State where slaughtered. Any owner of any establishment in which inspections are being made under the provisions of the act of March 3, 1891, who shall willfully cause or permit any animal which, upon inspection, has been found to be diseased to remain on said premises beyond the time allowed by the inspector in charge for its removal, shall forfeit his right to inspection, and said establishment will, for such time as the Secretary may direct, be refused certificates of inspection upon its products.

(8) The carcasses of cattle which leave said establishment as dressed beef will be stamped by said inspector with a numbered stamp issued by the Department of Agriculture, and a record of the same will be sent to the Department at Washington.

(9) Each and every article of food products made from the carcasses of animals inspected will be labeled or marked in such manner as the owner of said establishment may direct; said label, however, must bear the official number of the establishment from which said product came and also contain a statement that the same has been inspected under the provisions of the act of March 3, 1891.

A copy of said label must be filed at the Department of Agriculture, Washington, D. C., and, after filing, said label will become the mark of identification showing

that the products to which it has been attached have been inspected, as provided by these rules and regulations, and any person who shall forge, counterfeit, alter, or deface said label will be prosecuted under the penalty clause of section 4 of the act of March 3, 1891.

Each and every package to be shipped from said establishment to any foreign country must have printed or stenciled on the side or on the top, by the packer or exporter, the following:

FOR EXPORT.

(*a*) Official number of establishment.
(*b*) Location of factory.
(*c*) Number of pieces or pounds.
(*d*) Trade-mark.

In case said package is for transportation to some other State or Territory or to the District of Columbia, in place of the words "For Export" the words "Interstate Trade" shall be substituted.

The letters and figures in the above print shall be of the following dimensions: The letters in the words "For Export" or the words "Interstate Trade" shall not be less than three-fourths of an inch in length, and the other letters and figures not less than one-half inch in length. The letters and figures affixed to said package shall be legible and shall be in such proportion and of such color as the inspector of the Department of Agriculture may designate.

(10) The inspector of the Department of Agriculture in charge of said establishment, being satisfied that the articles in said packages came from animals inspected by him, and that they are wholesome, sound, and fit for human food, shall affix to the top of said packages meat-inspection stamps to be furnished by the Department of Agriculture, said stamps bearing serial numbers, and the inspector will write on said stamps the date of inspection.

The stamp must be securely affixed by paste and tacks in such a way as to be easily read when the package is standing on its bottom. Not less than five tacks shall be driven through each stamp, one at each corner and one in the middle of the stamp.

The stamp having been affixed, it must be immediately canceled. For this purpose the inspector will use a stencil plate of brass or copper, in which will be cut five parallel waved lines long enough to extend beyond each side of the stamp on the wood of the package. At the top of said stencil will be cut the name of the inspector and at the bottom of said stencil will be cut the district in which inspection is made. The imprinting from this plate must be with blacking or other durable material, over and across the stamp, and in such manner as not to deface the reading matter on the stamp, that is, so as not to daub and make it illegible. The stamp having been affixed and canceled, it must immediately be covered with a coating of transparent varnish or other substance. Orders for stamps must be made by the inspector on the chief of the Bureau of Animal Industry.

(11) Whenever any package of meat products bearing the stamp of inspection shall have been opened and its contents removed for sale the stamp on said package must be effaced and obliterated from the package.

(12) Reports of the work of inspection carried on in every establishment will be forwarded to the Department by the inspector in charge, on such blank forms and in such manner as will be specified in "Instructions to inspectors of slaughtering establishments."

SWINE.

(13) The inspection of swine for export or interstate trade will be conducted in the same manner as prescribed in the foregoing rules, with the addition, however, that a microscopic examination for trichinæ will be required for all swine products.

(14) When the slaughtered hog is passed into the cooling-room of said establishment, the veterinary inspector in charge, or his assistants, will take from each hog two samples of muscles, one from the "pillar of the diaphragm" and the other from another part of the body, and said samples will be put into a self-locking tin box and a numbered tag will be placed upon the hog from which said samples have been taken and a duplicate number of said tag will be placed in the box with said samples. The boxes containing the samples from the hogs in the cooling-room, so tagged, will be taken to the microscopist for such establishment, who shall thereupon make a microscopic examination of each box containing samples, and shall furnish a written report to the inspector in charge of the cooling-room, giving the result of said microscopic examination, together with the numbers of the hogs from which samples have been examined.

(15) All hogs reported by the microscopist to the inspector in charge of the cooling-room to be affected with trichinæ will at once be removed from said cooling-room

of said establishment under the supervision of said inspector or one of his deputies, and be disposed of by the owner in such manner as may be required by the laws of the State where such factory is situated.

(16) The inspector in charge of the slaughtering or other establishment will issue a certificate of inspection for all carcasses of animals or the food products thereof which are to be exported into foreign countries, which certificate will cite the number of the factory, the name of the owner or owners operating the same, the date of inspection, and the name of the consignee and country to which said articles are to be exported. Said certificate will also contain the numbers of the stamps attached to the articles to be exported. One certificate only will be issued for each consignment. The certificates will be issued in serial numbers and in tripicate form. One copy thereof will be delivered to the consignor of such shipment, one copy will be attached to the invoice or shipping bill to accompany the same and be delivered by the transportation companies to the chief officer of the vessel upon which said consignment is to be transported, and the third copy will be forwarded to the Department of Agriculture for filing therein.

J. M. RUSK,
Secretary.

Meat inspection was instituted under these regulations on May 12, 1891, at the abattoir of Eastman & Co., New York, N. Y., and was confined to the inspection of their export dressed beef. At the beginning of June, 1891, this work was inaugurated in Chicago, and soon thereafter at South Omaha, Nebr.; Kansas City, Mo.; Milwaukee, Wis.; Jersey City, N. J.; and Hammond, Ind. Microscopic examination of hogs was commenced at the abattoirs of Nelson Morris & Co., Armour & Co., and Swift & Co., Chicago, Ill., on June 22, 1891.

Since the commencement of this work to October 31, 1891, 1,587,976 animals have been inspected both before and at the time of slaughter. Of this number 1,226,675 were cattle, 25,116 calves, 163,835 sheep, and 172,350 hogs. There were 467,918 quarters of dressed beef tagged for export and 2,818,798 for interstate trade. In addition, 312,683 packages of canned, salted, and smoked meats were stamped in accordance with the regulations.

The following table shows in detail the work of meat inspection from its commencement to October 31, 1891:

Statement showing meat-inspection work from its commencement May 18, 1891, to October 31, 1891.

Character of work.	May.	June.	July.	August.	September.	October.	Total.
Cattle inspected	6,063	77,823	180,243	242,366	338,081	382,094	1,226,675
Beef quarters tagged for export	16,769	50,035	99,783	88,522	113,040	99,769	467,918
Beef quarters tagged for interstate trade	....	165,378	499,586	583,318	761,180	809,336	2,818,798
Beef carcasses tagged for other establishments	....	15,050	27,652	110,086	101,165	133,005	386,958
Packages of canned meat stamped	....	1,594	26,662	45,096	71,922	90,480	235,754
Packages of salted meat stamped	....	25	861	1,686	5,266	21,180	29,018
Packages of smoked meat stamped	....	28	768	8,758	16,525	21,832	47,911
Hogs examined microscopically	....	2,216	9,655	14,650	36,851	108,978	172,350
Packages of salted pork stamped for export	....	....	....	....	248	1,218	1,466
Packages of bacon stamped for export	....	....	....	....	329	....	329
Packages of hams stamped for export	....	....	....	....	104	....	104
Sheep inspected	....	....	5,766	33,001	54,564	70,504	163,835
Calves inspected	....	....	....	5,233	9,097	10,786	25,116
Export certificates issued	9	30	72	79	165	282	637
Total number of animals whose products have been marked for identification	6,068	79,967	195,311	294,708	437,583	570,446	1,584,083

The workings of this inspection and the carrying out of our regulations were watched with careful scrutiny by the representatives in this

country of foreign governments, and the first result of this microscopic examination of hogs was the order made by the German Government on September 3, 1891, removing the prohibition that it had maintained since 1881 against the importation of American pork products. The removal of this prohibition by Germany was followed within a short time by the removal of a similar prohibition by Denmark, and later by Italy, France, and Austria.

The importance of opening the foreign markets once more to an unrestricted importation of American pork products can hardly be overestimated, as affecting the farmers of this country. Prior to the full enforcement by foreign countries of their policy of prohibition, our export trade amounted, in 1881, to $69,000,000 in pork products, excepting lard, which product has never been restricted. In 1891 we exported $50,494,375 in pork products, excepting lard, showing a difference and loss of $18,505,625 between the exports of 1881 and 1891. The exports during the whole period of prohibition averaged about $43,000,000 per annum, and the removal of these foreign restrictions should, therefore, give a market that will increase our export trade in these products at least $26,000,000 a year.

COST OF THE WORK.

It is exceedingly difficult to estimate the cost of the new branches of work undertaken by the Bureau of Animal Industry during the past year. This difficulty is increased by the fact that the amount of work done each month and the cost of the same fluctuate with the demands of commerce for our cattle and their products.

The work of inspection of export animals, provided for by the act of Congress of August 30, 1890, has now been in operation for about twelve months. The average cost of this character of work during this period has been at the rate of $8,500 per month. During certain months it has gone as high as $10,279, and again has fallen as low as $7,400. As an average it might be estimated that the cost of export cattle inspection, which covers the work at interior stock yards, tagging, recording, and inspecting at the foreign animal wharves in Great Britain, would be $100,000 per annum.

The cost of maintaining the supervision of the movement of Southern cattle was at an average expenditure of $2,275 per month, or for the ten months during which these regulations are enforced, $22,750.

The inspection of imported animals arriving in the United States from Canada amounts to $775 per month, or $9,300 per annum.

The work of meat inspection has only been fairly in operation since the commencement of the present fiscal year. The cost of the inspection of animals in this work during the month of July, which includes the examination at time of slaughter, the tagging of quarters of dressed beef going into the export or interstate trade, and the stamping of packages of canned and salted beef and pork products, amounted to $5\frac{7}{10}$ cents per head for each animal inspected, or a total for 195,664 animals in the month of July of $11,160.71. This cost per head was reduced in the month of August to $4\frac{3}{4}$ cents per head, being a total number of 295,250 animals inspected at a cost of $13,981.39. A still further reduction in the cost of this work was accomplished during the month of September, when 438,593 animals were inspected at a cost of $14,200, an average of $3\frac{1}{4}$ cents per head. During the month of October the total cost of inspection was $16,392.28. The number of animals inspected was 572,489, making the average cost of inspection 2.86 cents per animal. It seems probable that the inspection of animals and their

marking for identification may be accomplished for a sum not exceeding 3 cents per head.

These figures, however, do not include the cost of microscopic inspection of hogs. This latter branch of the work has not been in operation long enough to be properly estimated for. At the commencement of the work it was necessary to educate examiners in the performance of their duties, and some little time was required for their becoming proficient and rapid in their examinations. Another difficulty that has been met with is the fact that several abattoirs which are being supplied with this character of inspection do not keep our examiners supplied with the quota of samples designated in their application for this inspection. The cost of microscopic inspection during the month of July amounted to 20⅓ cents per hog; during August it was 13⅓ cents per hog; during September, 8⅔ cents; and during October, 5⅓ cents. The number of samples which each examiner should examine in this work is about fifty per day; and, taking this number as the average, the cost of the inspection would be about 5½ cents per animal. It is thought, therefore, that the inspection work undertaken by this Department under the direction of Congress can be made at 3 cents per head for cattle and 5½ cents per head for hogs.

The demand for this inspection by the various packing and slaughtering establishments throughout the country is on the increase. Twenty-two establishments are now having their products inspected, and there are a number of other applicants whose requests have not been complied with, owing to the fact that the appropriation for the Bureau is not sufficiently large to be drawn upon further for this branch of work. It is most earnestly recommended that Congress be asked to make an appropriation for this work sufficiently large to enable this inspection to be extended to all applicants. It might be suggested that this branch of work was not considered by Congress, at its last session, in making appropriations for the Bureau of Animal Industry, as the bill providing for the work was not passed until the closing days of Congress. The benefits which have already accrued by the opening up of the foreign markets to our pork products, the increased demand for beef products, and the reëstablishment of their reputation for wholesomeness and soundness in the markets of the world, together with the protection which inspection gives to our own consumers, justify Congress in providing such an appropriation.

It may be stated in this connection that during the past three or four years considerable agitation has taken place in a number of States relative to the character of animals slaughtered for the interstate trade in dressed beef at the large central abattoirs of the country, and that State legislation was enacted as a police regulation of certain States in order to guarantee to consumers the wholesomeness of the food which was sold for their consumption. This legislation by several States was declared by the Supreme Court of the United States to be invalid, since it was a measure affecting interstate commerce, and belonged exclusively to the General Government of the United States. It is plain, therefore, that the only protection from unwholesome or diseased meat which the citizens of the greater part of the United States can obtain in the present condition of the meat trade must come from the national inspection service. The extension of the inspection and the thorough enforcement of the regulations are consequently matters which interest not only that portion of our people engaged in agricultural pursuits, but to an almost equal degree every citizen of this country.

DIVISION OF ANIMAL PATHOLOGY.

The Division of Animal Pathology, as at present organized, includes all scientific investigations in regard to the nature, prevention, and treatment of animal diseases.

During the summer considerable time had to be spent in fitting up the new laboratory provided for by the last Congress, and in transferring apparatus to it. Though experimental work was not stopped at any time, it was more or less interfered with during July and the early part of August. The new quarters are superior to the old in every particular, and the Bureau is now for the first time provided with all the apparatus and modern appliances which are required for this class of investigations.

The studies of Texas fever have been continued during the summer. The results of the experiments confirm the conclusions of 1890, throwing new light upon the nature of the disease, and strengthening the hope that its means of transmission will soon be fully understood, and the best preventive measures determined.

The work on swine diseases has occupied the attention of the division throughout the year. A Special Report on Swine Plague was prepared with great care, which gives in detail the work done by the Bureau since 1886 in different parts of the country.

Inoculation as a means of preventing the diseases of animals; the different forms of pneumonia in cattle; andt uberculosis, are among the subjects which have been carefully studied.

The investigation of animal parasites is being actively prosecuted with reference to our domesticated animals. These parasites are responsible for a large amount of harm, which is becoming more apparent by patient research. The material for a report on the animal parasites of cattle is now being collected.

Other diseases are being investigated as time and opportunity offer, and much valuable work is being done in determining the essential cause of various animal plagues. The results of all the investigations will be published in detail in the reports of the Bureau or in special bulletins.

DIVISION OF FIELD INVESTIGATIONS AND MISCELLANEOUS WORK.

A corps of inspectors is constantly employed in making investigations as to the character, etc., of reported outbreaks of contagious diseases in various States. As an example of the necessity and importance of such work, it may be stated that foot-and-mouth disease has recently been reported as existing in the West, and that this report was cabled to Europe, leading to demands there for the entire prohibition of our live-cattle trade. Upon careful investigation, however, it was demonstrated that the disease in question was not contagious, nor communicable even by direct inoculation, but was due entirely to local causes; and the official statement of this conclusion has been sufficient to quiet alarm and prevent adverse action by foreign countries. There has been less disease of all kinds than formerly among our animals, and happily many of the contagious diseases common or occasional in other countries do not exist at all with us.

This division also maintains a corps of correspondents, the object being to have one or more in every county of the United States, from

whom information is collected as to the condition of live stock, the diseases from which this industry suffers, and the various conditions in regard to which the farmers need additional knowledge. This enables the Bureau to keep in touch with the stock-raisers, and encourages them to correspond with it in those cases where it can be of service to them. The division is, therefore, to some extent, a bureau of information, and as such is growing in usefulness as its methods are perfected, and as its employés become more familiar with the wants of the people who apply to it.

This division is also charged with a supervision of the expenditures and accounts of the whole Bureau, a service which is absolutely necessary because of the great extension of the work and the large numbers of employés stationed in various parts of the country.

QUARANTINE DIVISION.

Stations securely inclosed and provided with suitable sheds, yards, and conveniences for the care of stock have been maintained for the ports of Boston, New York, and Baltimore. Cattle brought to these ports have been quarantined for a period of ninety days from the date of arrival at the station. Although the number of cattle imported during the year has not been large, the quarantining of them has been a necessary precaution to prevent the possible introduction of contagious diseases from foreign countries. The large expenditures which have been made by this country to exterminate such diseases from its borders have made this precaution of special importance to prevent the possibility of the reinfection of the United States.

In addition to the quarantine of cattle, a quarantine of fifteen days has been required upon all sheep and swine brought into the United States at these ports. The number of pure-bred sheep imported has been largely increased over that of other years, which also makes this precaution of detention under veterinary inspection especially important and desirable. When the demand for pure-bred animals is in excess of the supply, the tendency of those engaged in the business is to exercise less care to select only healthy animals and guard them against exposure to disease. The importation then becomes purely a business enterprise, in which many speculators engage with a manifest desire to curtail expenses without especial regard to the ultimate loss which might result to buyers. The need for careful inspection under Government control is, then, more apparent. No important cases of disease have developed in either of the quarantine stations, and the vigilance of the officers of this Department has not been relinquished. The uniformly healthy condition of our flocks and herds in America makes it imperative that a strict oversight should be placed over all animals brought from foreign countries, to prevent the introduction of such exotic maladies as would lead to heavy losses or possibly ruin an important industry.

PUBLICATIONS.

I take pleasure in calling attention to the great value of, and unprecedented demand for, the Special Report on Diseases of the Horse, written by the most eminent veterinarians of this country, and issued as one of the publications of this Bureau. If we may judge by the character of letters received commending this work, it is within bounds

to say that it is one of the most useful publications ever issued by the Government, and that it is worth to the people of the country the entire sum appropriated to the Department of Agriculture for the year. A similar work will soon be issued on diseases of cattle, which it is expected will be of equal value.

The demand for the Special Report on the Animal Parasites of Sheep has continued during the year, and has only been exceeded by that for the Report on Diseases of the Horse. The preparation of the two volumes just mentioned was, to some extent, a variation from the precedents established in the Department of Agriculture. It was an endeavor to go beyond the monograph, and give the farmer a book of reference on a more extended subject. The unusual success of both publications shows that there is a popular demand for information in this form, and that the monographs alone are not sufficient to supply all the needs of our farmers. There is undoubtedly a field for both classes of publications. The monograph is the best form in which to present new information and the results of original scientific investigations. It is necessary in order to keep the agriculturist abreast with the times. But every farmer must have a wider range of knowledge at his disposal than he can obtain in the form of monographs; and he must have this knowledge classified and condensed if he is to obtain the full benefit of it. It is to supply this want that the volumes of a more general nature are now being issued. The monographs, however, will be continued as the proper form in which to convey new information on each individual topic, and their substance will eventually be incorporated in revised editions of the more comprehensive volumes. The Sixth and Seventh Annual Reports of the Bureau are comprised in one volume, which is now in press, being published by special authority of Congress. A special report on sheep husbandry, prepared with much care, is nearly ready for the printer. A monograph on swine plague has recently been issued, and one on Southern cattle fever, better known popularly as Texas fever, is nearly ready for the press. These two monographs contain the investigations of the Division of Animal Pathology on these subjects, investigations which are so important and comprehensive as to revolutionize previously accepted views in regard to the nature of these two diseases. The material for other equally important reports is being rapidly accumulated. There is a large field of information bearing upon various branches of the animal industry which has heretofore been neglected for the most part in this country, and as a result there is more dissatisfaction and depression in this industry than is justified by the condition of the various markets. It is a period of sharp competition in the markets of this country and of the world, and those farmers can only reach the highest degree of success who are able to avail themselves of all the knowledge bearing upon their business, and particularly of the latest results of scientific investigations.

The following brief account of the investigations conducted under my direction into the nature of the infectious and parasitic diseases of animals, by Dr. Theobald Smith, Chief of the Division of Animal Pathology, and by Dr. E. A. v. Schweinitz, contains a review of the more important scientific investigations.

INVESTIGATION OF INFECTIOUS DISEASES OF DOMESTICATED ANIMALS.

By Dr. Theobald Smith.

The work of investigating communicable diseases of domesticated animals has been continued throughout the year at the laboratory and the experiment station.

During August the laboratory was transferred from the attic of the general building to a newly erected house two squares removed. The old quarters had been wholly unsuited to the work, and it was only by patient, persevering labor that the various disadvantages could be minimized in their injurious effect on the work. The great fluctuations of temperature in winter made it impossible to carry on delicate work with the apparatus on hand. In summer the high temperature of the rooms also interfered with certain kinds of work. Lastly, it was undesirable to carry on work with animal diseases communicable to man in the Department building. These difficulties have been largely removed in the new laboratory. This has found a home in a brick building 33 feet wide and 50 feet deep, consisting of three stories and a basement. A boiler in the rear supplies enough power to run a vacuum and an air-pressure pump, besides supplying the building with steam and hot water.

In the basement are kept the smaller experimental animals, so indispensable in the investigation of the causes of infectious diseases as well as of preventive and curative agents. On the first floor are two rooms, one devoted to the study of animal parasites of domesticated animals, and in charge of Dr. C. W. Stiles. The other contains the books, periodicals, and desks of the assistants of the laboratory. The second floor is set aside for pathological and bacteriological work, while the third is devoted to chemical work, and in charge of Dr. E. A. v. Schweinitz.

The experiment station, in charge of Veterinarian F. L. Kilborne, has occupied the same grounds since 1884, when it was briefly described in the first annual report of the Bureau of Animal Industry. It has since then been improved by a few necessary wooden structures, in which experiments on large animals, autopsies, and other work which can not be done in the laboratory or away from the experimental animals is carried on. The separation of station and laboratory, though at present unavoidable, causes more or less loss of time, since the work is practically one in both places. It likewise necessitates a more artificial division of labor in the investigation of diseases than is often desirable.

The following pages are devoted to a brief account of the work done during the year, and of the practical inferences which may be drawn therefrom. The complete details of the experiments are passed over to be published when the work has been finished.

As the investigation of infectious diseases is being carried on the world over, it is becoming more and more manifest that their nature is very complex. Each disease has its own special peculiarities, which can be discovered only by prolonged patient research. The discovery of the specific bacteria or other microörganisms belonging to each infectious disease is but the beginning of our knowledge. It then becomes necessary to study the life of these microörganisms, their mode of existence outside of the body, the changes they pass through, and the manner in which they gain access to the body. It becomes no less necessary to study the conditions of the body by which disease is either called forth or prevented. It is necessary, in other words, to

find out why certain animals take a disease and others not, and, after we have found out why, to put the susceptible in the same condition as the insusceptible. We either endeavor to vaccinate or else to put them in such healthy surroundings as will enable them to remain well even in the presence of certain disease germs.

These few statements illustrate the difficulty of the subject, and they also indicate that in order to become a successful breeder of animals a certain education is required nowadays, especially with reference to the more common, universal facts about bacteria and about disease in general. This education becomes the more imperative, since the growing intercourse between different parts of our own country and between our country and other countries affords an opportunity for the dissemination of new plagues and diseases of whose existence we had no information hitherto. The farmer, through his knowledge of the general laws governing infectious diseases, may thus be able to prevent the occurrence of many otherwise unavoidable calamities.

It must be evident, however, to all unbiased readers that the growth of our knowledge concerning infectious diseases is exceedingly slow, owing to the difficulties to be overcome in investigations. The objects to be investigated are so minute that they stand at the limits of our vision even when armed with the most powerful microscopes which the world to-day produces. The information concerning them is little more than ten years old, and frequently has to be modified after repeated investigation with more exact methods. The facts of one year must be expanded another year and the practical deductions readjusted. To illustrate this we may cite our experiences with hog cholera. When the bacillus of this disease was first discovered and its life history studied in 1885, it was taken for granted, in harmony with the views then prevailing, that this bacillus would be always the same wherever found. But it was soon determined that it varied considerably in its virulence. Some varieties had so little disease-producing power when inoculated into animals that several new problems arose. Can these attenuated bacilli ever produce disease under natural conditions; and if they do, what conditions aid them in this work? Not only does the virulence of the disease vary with the variable character of the bacilli, but the character of the disease itself becomes changed. The bacilli are no longer found regularly in the organs where we are accustomed to find them, and thus the diagnosis or the determination of the exact nature of the disease becomes a matter of much labor for the bacteriologist. Similar experiences in investigations of swine plague will be given farther on.

These statements will, it is thought, make plain how our increasing knowledge demonstrates that each disease has features of its own which can not be presumed to belong to other diseases without careful investigation. It will likewise be readily inferred that it is often necessary in collecting our information to make apparently wide excursions from the object to be investigated in order to secure a sufficiently broad and accurate basis for the work to be done. This is not infrequently prepared for us by the investigations of other workers, especially in Germany and France, both in the field of human and animal diseases. But we are as frequently compelled to prepare such a basis ourselves. It thus becomes necessary to extend the work over a period of several years before it is safe to draw any conclusions whatever. It need not be insisted on, therefore, that hasty generalizations may be more injurious than none at all. With these introductory remarks we proceed to a brief review of those subjects which received special attention during the year.

SWINE PLAGUE.

In the course of the year a special report of 160 pages was submitted, which embodied all the investigations which we have had the opportunity to make. In this report the records of the experiments and observations are published in full, and we give now only a brief summary of the practical deductions, which may be of value to those interested in rearing swine.

The investigations had led to the conclusion that there is a disease of swine mainly limited to the lungs different from the cholera. This disease is largely associated with hog cholera, so that it is impossible to estimate what percentage of the losses are due to it. Its distribution seems to be as wide as that of hog cholera. It is caused by bacteria, readily distinguished from hog-cholera bacilli in a variety of ways. These bacteria in pure cultures can be made to produce by inoculation the disease itself in healthy animals. Moreover, the disease is communicable, as was demonstrated in 1890, by placing healthy and diseased pigs in the same pen. The undoubted case of swine plague produced in this way is described in the Special Report, on page 69. The proof that swine-plague bacteria do produce a fatal infectious disease is thus complete, and any further discussion of this part of the subject is useless. The problems which have arisen in connection with this disease, as to its origin, its communicability, its prevalence, its mortality, have been greatly complicated by its frequent association with hog cholera. Nevertheless we have gained some important knowledge which, though by no means complete in itself, is destined to shed light not only on this disease, but on kindred diseases of other domesticated animals.

As far back as 1887 the writer, having studied the properties of the swine-plague bacteria, found them very perishable. The question then arose how they were transferred from animal to animal and from place to place. If they perish quickly in the soil and water by drying, etc., it seemed very likely that they were communicated chiefly by animals themselves. We examined the mouth and throat of various herds of apparently healthy swine, and found in some of them bacteria not distinguishable from those of swine plague, excepting that they were, as a rule, less virulent. We then extended our investigations to other domestic animals and found that in their air passages the same kind of bacteria were frequently present.* In some animals, as in cats, for instance, they were of exceptional virulence. We thus came upon the important fact that in the mouths and upper air passages of cats, dogs, cattle, horses, and pigs bacteria exist which are practically identical, but which may vary considerably in virulence or disease-producing power. This implies a wide distribution of this group of disease germs, if it should be found that the same condition of things prevails in different regions and latitudes of our country. We have thus far examined only animals from the District of Columbia and a few Western steers, so that we are not yet entirely prepared to assume a similar distribution over the whole country.

Given these facts concerning the distribution of this group of swine-plague bacteria and their varying virulence, we may assume as probably true that—

(1) Swine are being constantly exposed to these bacteria by coming into contact with other domesticated animals.

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* See Swine Plague Report, p. 151, for details of experiments.

(2) Swine are not likely to be infected by attenuated or but slightly virulent varieties of these bacteria unless the infection is aided by other causes of a debilitating character.

(3) Very virulent varieties of swine plague may produce extensive outbreaks, and hence the same preventive measures are necessary which have been laid down for hog cholera.

(4) In many epizoötics of swine disease both hog-cholera and swine-plague bacteria, as well as the respective lesions of these bacteria, coexist. Such mixed diseases indicate wide distribution of these two kinds of bacteria.

(5) The same group of bacteria produces disease in different domesticated animals, and we may safely assume the occasional transmission of such disease from one species to another.

In the following pages we have endeavored to discuss and illustrate these propositions just laid down. In so doing we are well aware of the fact that they are not yet fully demonstrated. In applying facts of science, it is often necessary to anticipate actual demonstration of a presumed truth, especially when we are thereby put on the conservative side and our attention is aroused to probable dangers in the future.

(1) If we assume that the majority of swine are exposed to swine-plague bacteria in one of the various ways indicated, and that only a small number succumb to the infection, there must exist certain favorable or unfavorable conditions. These pertain either to the animal or to the bacteria, or to both together.

The conditions which make animals more susceptible to infection are as varied as the conditions which reduce their vitality. The importance of rearing and keeping animals in such a manner as to produce and maintain a healthy action of the various functions of the body has not been insisted upon with as much emphasis as it deserves, owing to the somewhat overshadowing influence which the study of pathogenic bacteria has exerted upon all minds. It is evident, however, that veterinary hygiene has much to do with the decline of large epizoötics, not only by keeping away the germs of the disease, but by enabling the animal body to resist their attacks. Of those conditions of swine which invite disease very little is as yet positively known, and we simply call attention to a few to arouse the interest of those who are in position to make observations.

There have been indications during the course of experiments at the Bureau Station that the breed may have some influence in predisposing to infection. As an illustration, we may cite an experiment in vaccination of swine against hog cholera carried on at the station in 1889–'90.* The vaccination, which consisted in subcutaneous inoculation of culture liquid, seems to have had no effect; for, when the time for exposure came, practically all pigs from one lot succumbed and all from another lot survived. The latter were Essex grades reared in pens; the former, grades of mixed Jersey Reds and Chester Whites not raised in pens. While it is impossible to give any facts as to the relative resistance of different breeds to swine diseases, it is a subject which should receive the due consideration of swine-breeders, especially in those States where swine diseases are more or less stationary. Age is another important element. We have found a decided difference in the susceptibility to both hog cholera and swine plague in favor of older swine. This element of age is familiar to all with reference to certain human maladies, such as scarlet fever, measles, diphtheria, and some other diseases which preferably attack the young.

Feeding is perhaps the most important factor in predisposing swine to disease. The assimilation of large quantities of food and its conver-

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* Report of the Secretary of Agriculture for 1890, p. 110.

sion into fat seems to be the one essential function of swine. This goes on to such a degree as to lead to pathological conditions after a time. Not only the ingestion of large quantities of food, but of one kind for a long time, is in itself opposed to the habits of such omniverous animals. Besides overfeeding upon one kind of food we have the uncleanly surroundings in which swine are apt to be kept, contributing materially to the collection and maintenance of bacteria of various kinds, which may be injurious. In addition to the unhealthy modes of existence to which swine are subjected, and partly springing from them, are certain pathological conditions induced by animal parasites of different kinds. The life history of some of the most important parasites infecting swine is still to be elucidated. As a rule, we have found in our post-mortem examinations a larger number and variety of internal parasites in those herds which have been allowed to run freely than those brought up in pens. The opportunities for infection seem to be much greater in the former case than in the latter.

As to the damage done by parasites it is difficult to form an accurate estimate from ordinary observation. Obvious damage may be done in the air passages by lung worms (*Strongylus paradoxus*), and in the small intestine by *Ascaris* and *Echinorhynchus*. The lung worms may be met with in all seasons of the year in swine up to three months old. They invariably inhabit the terminal portion of the two large bronchi of the principal lobes. Here there is generally a partial or total occlusion of the bronchus for 1 or 2 inches from the caudal border of the lobe, due to the lung worms and the enveloping mucus. In some cases the occlusion is followed by collapse and broncho-pneumonia of the lobes supplied by the bronchus and its branches. The hepatized lung tissue assumes a bright or pale red color. When the lung worms are very abundant larger branches of the same bronchus become filled with the parasites, and the broncho-pneumonia may extend over a greater portion of the principal lobes. That lungs in this condition are more susceptible to the invasion of swine-plague bacteria will be generally admitted. The bronchitis, begun where the lung worms mature, may extend after a time into the other air tubes.

Another question arises with reference to lung worms. Do they carry infectious germs into the lungs? This question can not be answered until more is known of the life history of these parasites. Meanwhile the evidence would hardly support the opinion that they introduce the virus. The pneumonia usually begins in the small ventral lobes and travels from them, while the lung worms begin their injurious work in the principal lobes farthest removed from the ventral lobes. All that can be said is that they may make the lungs more susceptible to the disease.

In the intestines *Ascarides* are not infrequently found extending into the common bile duct from the duodenum. Some even enter the gall bladder, while others imbed themselves in the ducts coming from the various lobes of the liver and completely obstruct the flow of bile. The *Echinorhynchus* is well known as attaching itself to the mucous membrane of the small intestine and producing ulcerous depressions, simulating those of hog cholera.

That there may be other predisposing causes at certain seasons of the year, such as obscure malarial diseases due to protozoa, the invasion of the muscular system by psorospermia (sarcosporidia), trichinæ, etc., need simply to be mentioned, since no positive evidence is at hand.

The most important factor in the production of swine plague and hog cholera is the virulence of the bacteria. In the report referred to much

experimental evidence is presented to show how much the disease-producing power of swine-plague bacteria from different outbreaks may vary. The same is true of hog-cholera bacilli. It may be laid down as a general rule that the more virulent the bacteria the more severe the resulting epizoötic, and the greater the mortality. While a more attenuated variety of bacteria may spare the older and more hardy animals of a herd, these will succumb to a more virulent variety. Attenuated or weaker varieties of swine-plague bacteria may attack the young and the badly kept swine, those infested with parasites and those of poorer breeds, while the stronger may not become diseased. This may explain also why some herds of swine are destroyed and neighboring ones escape, although both may have had the same opportunities of infection.

How do we know that some of these bacteria have more disease-producing power and others less? This problem is solved by experimental inoculation of swine and smaller animals. We have already called attention to the various grades of virulence among hog-cholera bacilli. The same statements apply to swine-plague bacteria. In the report quoted, cultures of swine-plague bacteria from Germany were shown to be the most virulent, for they were fatal when only a small quantity was introduced under the skin. Of our own varieties none produced disease when introduced under the skin (excepting in a single case), but it was necessary to inject them into the blood or into the lungs to produce a fatal result.

There is an important practical lesson to be drawn from these facts. Although there may be infectious swine diseases in a given locality which carry off now and then a few animals, such diseases may not become widely distributed because not sufficiently virulent, and particularly well kept herds or certain breeds may escape disease even though exposed to infection. But what is to prevent a very virulent variety of hog-cholera or swine-plague bacteria from being brought into such a locality at any time, of developing into an epizoötic, and sweeping off animals whether old or young, weak or strong? The actual existence of disease should not close the eyes of swine-breeders to even greater dangers due to the importation of still more virulent and destructive varieties of the same disease. In other words, even the constant presence of swine disease should not make the owners of herds careless in the application of preventive measures.

(2) If, then, it is very important to guard against the importation of swine-plague bacteria in diseased herds as having the highest degree of virulence, what are the vehicles by which such swine-plague bacteria are conveyed from place to place?

In the Report on Swine Plague it was pointed out that swine-plague bacteria are far less hardy than hog-cholera bacilli. The former perish rapidly in water and in liquids unsuited to their multiplication. They survive drying for a few days only. In general, they speedily disappear after they have left the body of diseased swine, and it is highly doubtful whether they would survive a month in the soil or in pens. Such agencies as streams, manure, etc., which may distribute hog-cholera bacilli over considerable distances, are of restricted importance in swine plague. The chief danger lies in contact with diseased or infected swine. Intermediate carriers of infection can only act for a short time, while swine may harbor disease germs for months in localized inflammations, such as abcesses under the skin and in the joints, and it is possible that they may vegetate on the mucous membranes of the air passages indefinitely.

Swine must thus be regarded as the chief vehicle of infection. This

may be conveyed directly from diseased to healthy animals; it may be conveyed by those which have passed through the disease, and hence by older to younger swine. It is safe to assume that any swine which have at any time been exposed to swine plague (or hog cholera) are liable to convey the disease, because we do not know when the specific disease germs leave the body.

Other sources of danger are railroads leaving fresh manure in different places, the vicinity of slaughterhouses, rendering establishments, or any other places where the viscera of swine may be scattered or where numbers of living swine are temporarily housed. If we bear in mind the wide distribution of infectious swine diseases it is easy to believe that in any large herd of swine collected from different localities there are always liable to be some diseased or infected. It is essential, therefore, in guarding against disease, to look with suspicion upon all swine the history of which is not known, to some extent at least.

There is a practice current in some parts of the country of gathering together herds of young pigs from various localities through the intervention of dealers. In regions where swine diseases are prevalent much of the time, and where the virus never dies out, this is a specially dangerous practice. While swine may not be visibly diseased, or may simply appear somewhat unthrifty, they still may carry the seeds of a virulent outbreak within them which need but a little time to gain the required momentum. The mild character of a disease in any one animal is no evidence of the character of the germ; for this mildness may be due to a very virulent germ acting upon a highly insusceptible animal and causing a more prolonged chronic disease. In fact, these partly insusceptible animals are the most likely to appear in the markets, because they are the remnants of herds destroyed by disease. We have frequently been able to demonstrate by experimental inoculations the general accuracy of these statements. Thus, bacteria obtained from inoculated cases in which the disease had taken a more chronic course had not lost any of their virulence. In experiments bearing on vaccination we have been able to increase the insusceptibility of rabbits and guinea-pigs so that virulent bacteria produced only a mild form of the disease, prolonged from days to weeks and even months. Yet the bacteria cultivated from such cases and injected into animals not vaccinated showed no loss of virulence. Again, we have found swine-plague bacteria in swine inoculated two months previously but apparently well at the time of examination, and in case of hog cholera we have found the bacilli in the organs of swine six to seven months after apparently unsuccessful inoculations. These bacteria possessed the original virulence.

The question has frequently arisen in the course of these investigations, Whether the bacteria are ever introduced into herds in the food? This involves another question, Whether hog-cholera or swine-plague bacteria do exist independently of diseased or healthy animals? As to both kinds of disease germs there is at present no evidence to show that they live outside of the animal organism, except temporarily, and that if the food happens to be infected, the infection has come from animals directly or indirectly, and that it is simply a question of time whether such infection is still in a living condition or not. Food, however, may be infected with other pathogenic bacteria which may become dangerous in producing secondary and perhaps fatal lesions in animals already diseased.

(3) We have repeatedly called attention to so-called mixed diseases in which both hog-cholera and swine-plague bacteria are found. This

can only be explained by a wide distribution of both hog-cholera and swine-plague bacteria. The practice, already alluded to, of purchasing pigs from many herds and localities and bringing them together to be fattened as one herd is the most successful method of bringing various grades of pathogenic bacteria together and of producing a mingling of two diseases. These mixed outbreaks may develop in other ways also. The disease may begin as hog cholera and become subsequently complicated with swine plague, or the reverse may be true; the disease may begin as swine plague and become complicated with hog cholera. In either case the most virulent variety will probably start the disease, and any attenuated hog-cholera or swine-plague bacteria, which are latent in some of the animals of the herd or have not yet been killed out of the soil and the surroundings from a former outbreak, may start into activity and thus produce a more fatal mixed disease. It is evident that such secondary attacks of attenuated bacteria would not take place if the animals had not been weakened by the primary disease. This may be the only way in which the great majority of the swine-plague bacteria in the air passages of healthy animals can exert any pathogenic effect whatever. It is equally difficult to understand how attenuated hog-cholera bacilli can act without assistance from swine plague unless we accept such an explanation as the following: In swine plague some cases are usually of a more chronic type. The disease lasts some time, and is associated with caseous changes in the lungs. Any hog-cholera bacilli have thus abundant opportunity to enter the weakened organism through the diseased lungs, for instance, and appear after death in cultures from the internal organs. For the same reason hog-cholera outbreaks characterized by very feeble pathogenic activity of the hog-cholera bacilli, and hence of a more prolonged duration and chronic character, are usually complicated with swine plague, because the latter, even though of a feeble activity, has been able to invade the weakened organism and has had time to do so. In virulent outbreaks of either disease death may ensue so rapidly that no invasion of the other disease takes place. These statements presuppose, of course, that both kinds of bacteria exist in the surroundings of the herd.

There are no facts at hand to indicate any difference in the distribution of these two plagues. The localities where either one or both plagues have been determined by bacteriological investigations may be tabulated as follows:

Locality.	Character of plague.	
By the Bureau of Animal Industry:		
District of Columbia, numerous outbreaks, 1885–'90	Hog cholera	Swine plague.
Maryland, various outbreaks, 1885–'90	do	Do.
Virginia, various outbreaks, 1885–'90	do	Do.
Nebraska, 1886	do	
Illinois (Geneseo), July, 1886		Do.
Illinois (Sodorus), September, 1886	Hog cholera	Do.
Illinois (Ottawa), November, 1891	do	Do.
Iowa, December, 1886		Do.
Iowa (Mason City), November, 1888	*(?)	Do.
New Jersey (Johnsonburg), October, 1887	†(?)	
New Jersey (Pleasantville), July, 1890	(?)	Do.
Missouri (Chillicothe), 1890–'91	Hog cholera	Do.
Nebraska (1886–'88), by Billings	do	(?)
Maryland (Baltimore), by Welch and Clement	do	Swine plague.
South Carolina, by Bolton	do	
Illinois, by Burrill		Do.
Kentucky, by Burrill and Shakespeare		Do.
Massachusetts (near Boston), by J. A. Jeffries		Do.

* The investigation in Iowa did not bring to light any hog-cholera bacilli, though the lesions suggest the presence of attenuated forms not accessible by the usual methods.

† In this small outbreak bacilli closely resembling those of hog cholera were found in the spleen. Their virulence, however, was very feeble. Subcutaneous inoculation had no effect on rabbits.

(4) The question whether the different species of domesticated animals on a farm may take from or transmit to swine the disease which we have been considering is of very great importance in view of the changing conditions of live-stock interests, which are going on in different directions in various parts of our country.

The problem may be stated as follows: Has the bringing together of different species of animals for the purposes of feeding, etc., on the same ground, a tendency to increase disease in one or the other species? Will swine take swine plague from cattle, and will they transmit it to sheep and horses, for example, or is the reverse ever observed?

Investigations and observations during the past thirteen years lend some color to such possibilities, and it becomes necessary at least to call attention to those engaged in raising and keeping farm animals to what has been determined in this direction, and to arouse their interest in the investigation of outbreaks of swine plague, especially as regards the immediate causes.

In the summer of 1878 there appeared in three royal game preserves, in the vicinity of Munich, in Bavaria, a very fatal epizoötic among the wild boars and deer, of which 234 boars and 153 deer perished.* It was also noticed that even after the plague in the parks had apparently died out, disease among cattle in the neighborhood appeared, and this, according to the observations of veterinarians, was identical with the disease observed among the game in the parks.

The disease was very acute, lasting from twelve to thirty-six hours in the majority of cases. The chief lesions were croupous pneumonia, pleuritis, pericarditis, and mediastinitis. In cattle the disease appeared in two forms. In one a swelling was observed on the head, the face, the neck, or in the tongue, which assumed enormous proportions in six to twelve hours, and led to suffocation. The swelling was due to serous or serous and hemorrhagic infiltration. In the other form, in addition to the pneumonia, pleuritis, and pericarditis observed in the game, there was always present a severe hemorrhagic inflammation of the small intestine. At this time bacteriological methods were still undeveloped, and nothing is known of the nature of the bacteria causing this outbreak save the fact that they were not anthrax bacilli. A number of inoculations were made upon various animals, which testify to the extreme virulence of the specific bacteria.

Rabbits died six to eight hours and sheep and goats thirty to thirty-six hours after inoculation. Two old horses died after subcutaneous inoculation with blood from cattle in a very short time. A young steer one and one-half years old was fed with a thimbleful of the intestinal contents of a calf which had succumbed to an enormous swelling. The steer died in fifty-four hours with pneumonia and pleuritis. A pig inoculated subcutaneously over the left shoulder with a few drops of blood died in twenty-two hours. Besides an extensive erysipelatous swelling starting from the point of inoculation there was beginning fibrinous pleuritis.

The disease reappeared in the following years, either sporadically or in restricted outbreaks. In 1879 and 1880 it was observed among domesticated animals alone; in 1881 among the animals in the game preserves. In 1885 Kitt† published some investigations which were destined to throw more light upon this new plague. With blood from an outbreak among cattle resembling the epizoötic described by Bollinger, Kitt made some inoculations upon small animals. Of mice, rabbits, guinea-pigs, and one pigeon inoculated, the mice and rabbits died within twenty-four to thirty-six hours, the pigeon in thirty-six hours. The guinea-pigs were not affected. Lesions were in general absent. The blood contained large numbers of bacteria. Subsequently the spleens of an ox, a young pig (of which eight had died), and a horse which had succumbed in the same locality, showed on microscopic examination the same bacteria, whose virulence tested on rabbits was likewise the same. In a cow inoculated subcutaneously over the left shoulder an extensive inflammatory œdema of the inoculated shoulder appeared, which extended over the entire left limb. The swelling later became converted into an abscess, but the animal did not die.

Of special interest is the subcutaneous inoculation of a pig with a minimum quantity of mouse's blood. From the place of inoculation on the right thigh a bluish discoloration of the skin spread over the whole body in spots and patches, while there was considerable swelling at the place of inoculation. The pig was dead in

* Bollinger. Ueber eine neue Wild- und Rinderseuche. München, 1878.

† Ueber eine experimentelle der Rinderseuche (Bollinger) ähnliche Infectionskrankheit. Sitzungsberichte der Gesellschaft für Morphologie und Physiologie in München, I, 1885, s. 140-168.

twenty-four hours. The autopsy revealed, in addition to the lesions mentioned, exudative pleuritis and peritonitis, congestion of the mucous membrane of the upper air passages and of the stomach. A goat inoculated subcutaneously in the same manner was afflicted with extensive local inflammatory œdema and died within two days. A horse inoculated subcutaneously in the neck with a suspension from an agar culture, derived originally from the mouse, died within one and one-half days with extensive local reaction, fluid blood, ecchymoses on heart, pleuritis, and pericarditis, and beginning inflammation of the mucosa of the stomach. The bacteria found by Kitt have a marked resemblance to swine-plague bacteria, and their pathogenic effect on pigs and smaller animals is identical with that of very virulent swine-plague bacteria.

A disease probably identical with the foregoing was described by Oreste and Armanni,* as occurring among herds of young buffaloes in Italy. The disease appears very suddenly, and the animals attacked may die in from twelve to twenty-four hours. The symptoms are high temperature, rapid and feeble pulse, discharge of mucus from nose and mouth, associated with a local swelling on the head and face which leads to suffocation. The specific bacteria seem to be identical morphologically with swine-plague bacteria. The disease can be reproduced in young buffaloes by inoculation of cultures. It was similarly produced in a colt, a cow, a sheep, and in mice, rabbits, guinea-pigs, pigeons, and fowls. Death ensued in all animals in from one to three days. Of two young pigs inoculated one died, the other survived.

In France, Galtier† has found pneumo-enteritis of swine associated with a similar disease in sheep which came into contact with them. While there is much in favor of his assumption that the infection passed from the swine to the sheep, the description of the specific bacteria and of the methods of inoculation are not sufficiently complete and thorough to bring conviction as to the transmission, or furnish any definite information concerning the nature of the bacteria found. A few suggestions thrown out here and there are sufficient, I think, to permit us to exclude hog-cholera bacilli and regard them as belonging to the group under consideration.

These various investigations are of great importance in showing that some infectious diseases may either attack several species of domesticated animals at the same time, or be inoculable from one species to another. What is of special significance in the first two investigations is the extreme virulence of the bacteria. The same may be said of the Italian buffalo disease. The bacteria causing these outbreaks are, so far as it is possible to ascertain from the descriptions, all members of the swine-plague group of bacteria.

There is another class of infectious diseases, due to bacteria of the same group, which produce specific diseases among certain species of domesticated animals, but which diseases are not known to be communicable to other species. Among these are fowl cholera, rabbit septicæmia, and a peculiar form of pleuro-pneumonia in cattle, which Poels has called "septic pleuro-pneumonia." During the past three or four years the writer has examined in the laboratory of the Bureau of Animal Industry a small number of lungs from cattle affected with pneumonia, from which bacteria practically identical with swine-plague bacteria were isolated. A description and discussion of these forms of pneumonia in cattle will be reserved for a future report.

There is thus a wide distribution of diseases among domesticated animals due to a group of bacteria closely resembling and probably identical with swine-plague bacteria. Some diseases attack several species at the same time; others are, so far as we know, restricted to one species. We have also seen that there is a wide distribution of attenuated varieties among the same domesticated animals in the healthy state, inhabiting, so far as our investigations have gone, the upper air passages. Some observers are inclined to regard these different bacteria as practically the same. Hüppe has proposed the name

* Atti del R. Instituto d' incoraggiamenti alle scienze naturali, etc., 1887. For a brief account see also Journal de Médecine Vétérinaire, 1887, p. 585, and Baumgarten's Jahresbericht for 1887, s. 124.

† Journal de Méd. Vét., 1889, *passim*.

Septicæmia hæmorrhagica for all the forms of disease caused by them. Other observers hesitate to accept at present this unifying explanation. For practical purposes the following explanation, based on quite extended study of this group of bacteria, may serve as a provisional guide in the prevention of disease:

The real test of the power of any bacteria to produce disease is virulence. The greater the virulence the more liable will be the disease to spread from one species to another. This is strikingly illustrated by the *Wildseuche* of Bollinger. The relative virulence can be accurately determined only by careful series of inoculations upon small and large experimental animals, performed in precisely the same way in each case with pure cultures of the bacteria. Again, the power of a given disease to pass from one species to another frequently remains unnoticed, partly because in many cases there is not sufficient opportunity for such transmission. The nature of food required for each, and other conditions lead to specialization in stock-raising, and tend to restrict each species to its own pasture ground.

It is not unreasonable to suppose that bacteria living in the air passages of one species, and harmless to it to a certain degree, may prove to be disease germs with reference to another species. Thus the attenuated bacteria living in the air passages of healthy cats, dogs, pigs, and cattle are all fatal to rabbits and some to pigs. In general the larger and more powerful the animals the less effect disease germs have upon them. It is, therefore, possible that some of the outbreaks of swine disease in the Western States may be due to the cattle with which the swine are herded for feeding purposes. The bacteria in cattle, harmless to them, or perhaps causing only mild disease and rarely observed, may prove the starting point of disease for swine.

While we have no positive demonstration of these statements, it is desirable that those engaged in stock-raising should have their attention called to the possibilities embodied therein.

(5) In regard to the general measures to be taken and the rules to be observed in the prevention of hog cholera and swine plague, we refer the reader to the Report of the Secretary of Agriculture for 1888, page 156, or the Report of the Bureau of Animal Industry for 1887-'88, page 148, or the Special Report on Hog Cholera, 1889, page 123. The rules and directions there formulated are adapted as well to swine plague, for the bacteria of the latter disease are even more easily destroyed by various agencies than are hog-cholera bacilli. In the following pages only the most important points are touched upon.

The things with which healthy swine should not come into contact are, in the order of their importance, first of all, diseased herds and animals, strange swine the history of which is not known, offal from establishments using carcasses of swine, recently infected ground, railroads carrying swine, and polluted streams. Soil and water may be infected by living and dead swine or any offal from them.

When the disease has actually appeared in a herd the question generally arises whether it is worth while to make any attempts to save a portion of the herd or to leave them to their fate. As a rule it may be stated that it is best to slaughter both healthy and diseased at once and give the surroundings sufficient time to rid themselves of the infection before fresh animals are brought into them. If this be not desirable we should recommend the following measures to be rigorously carried out:

(*a*) Removal of still healthy animals to uninfected grounds and pens as quickly as possible.

(*b*) Destruction of all diseased animals.
(*c*) Careful burial or burning of carcasses.
(*d*) Repeated thorough disinfection of the infected premises.
(*e*) Great cleanliness both as to surroundings and as regards the food.

If the animals have been removed to uninfected grounds, careful watching is necessary to remove therefrom at once all swine which show signs of disease.

Among the various disinfectants which can be recommended are the following:

(1) Slaked lime, in the proportion of about 5 per cent (one-half pound of lime to a gallon of water).

(2) Equal volumes of crude carbolic acid and ordinary sulphuric acid mixed together and added to water in the proportion of 2 ounces to a gallon of water ($1\frac{1}{2}$ volume per cent).

(3) Sulphuric acid, added to water in the proportion of 1 ounce to a gallon.

(4) Boiling water.

(5) Corrosive sublimate (mercuric chloride), in the proportion of 1 drachm to a gallon of water (1 to 1,000).

Solution No. 2 is said to be more active if, while the sulphuric acid is being added to the crude carbolic acid, the vessel containing the latter is placed in cold water to prevent undue heating of the liquid.

It should be borne in mind that sulphuric acid and corrosive sublimate attack metals, and that the solutions are best made in wooden pails, etc. Corrosive sublimate is also highly poisonous, and the solution should not be made stronger than indicated. The lime is, on the whole, the best and cheapest, but it may not be desirable to use it everywhere; hence one of the others may be substituted. Each of the solutions recommended is more than strong enough to kill hog-cholera and swine-plague bacteria and they need not be increased in strength.

When swine have become infected while running over tracts of ground, disinfection of such tracts may be regarded as practically impossible. If, however, they have been brought up in pens or in small inclosures, disinfection should be thoroughly carried out. The woodwork of pens may be disinfected by exposing all portions, cracks and corners, to the action of any of the solutions mentioned. These may be applied with a broom or any other household article which insures uniform wetting. Whitewash is useful for woodwork of fences, etc., when there is no objection to its appearance. Its action is only exerted at the time of application, and after it has dried it will not destroy bacteria subsequently adhering to it. It must, therefore, be applied fresh every time disinfection is needed. For large farms some kind of spraying apparatus would be of great service in insuring uniform distribution of the disinfectant. In the selection care must be exercised, however, owing to the corrosive action of some of the solutions. The disinfection of the surface of the soil over small areas is perhaps best accomplished by the slaked lime or the crude carbolic-acid solution. It should be remembered that both preparations may be irritating to the feet of animals immediately after they have been applied. The feeding troughs should receive special attention, and after the application of the disinfectant this should be washed away with water, preferably hot or boiling.

The directions thus far given apply mainly to the prevention of disease. When animals have been actually attacked, can any thing be done for them? It has already been stated that treatment of communicable diseases is not a desirable thing, but even if it were the deaths follow each other so rapidly in many outbreaks that there is no time for the application of remedies. If, however, an effort to treat them is

to be made, it is desirable to avoid the various specifics and remedies of unknown composition, some of which, thoroughly tested at the Bureau Station by Dr. F. L. Kilborne, were of no avail in checking the disease. The sick animals should be isolated one from another, as far as possible confined in small inclosures, kept quiet, and fed with moderate quantities of food, preferably with milk, if this is to be obtained. If the swine are being fattened when the disease appears, this process should be stopped at once and a light diet substituted. The tendency towards the localization of disease in the large intestine, in both swine plague and hog cholera, seems to be due, at least in part, to the constipated habits of the pig, which permit the pathogenic bacteria to remain long enough in the intestine to act injuriously upon the mucous membrane. Constipation is not easily overcome, as the trials with various cathartics have demonstrated, and it is highly important when the disease has appeared to feed a greater variety in small quantity or to follow the recommendation of giving the digestive organs a complete rest by feeding milk. The boiling of food may be desirable, inasmuch as it destroys any disease-producing bacteria which may be present, and makes digestion easier. An experiment carried out at the Bureau Station with boiled food did not show any more favorable results, however, than with unboiled food ordinarily given, so we can simply suggest it for further trial.

Even if treatment should succeed after much trouble and expense to save some few swine, it may not be profitable, owing to the injury inflicted on the various organs during the disease. The lungs are, as a rule, seriously affected. They may become adherent to the walls of the thorax, and the pericardium may become thoroughly attached to the heart and impede its action. These permanent injuries, which no kind of treatment yet suggested can avoid, exercise an injurious influence on the proper development of the animal affected, and make its raising of questionable advantage. It has already been stated that such recovered animals may, for a time at least, be dangerous as carriers of the disease germs to other swine.

The only encouraging line of action, therefore, lies in the prevention of disease by the observance of suitable precautionary measures, and in that general practice of hygienic laws which thus far has been the only means of checking the rapid spread of epidemics in the human family. The method first suggested by Pasteur of inoculating animals with attenuated cultures to make them resist any and every attack of a given infectious disease is, theoretically considered, the simplest means of prevention. Practically, however, there are two general objections which are growing in importance year by year, as our knowledge of infectious diseases is becoming broader and deeper. The method of Pasteur may distribute the specific bacteria far and wide and become a source of future evil, since we do not know but that the attenuated bacteria may in some way regain their former virulence. The other objection rests on the fact that diseases differ so much one from the other that the method seems to insure success in only a few diseases of a certain character. Provided the animals are actually protected by inoculation, the first objection might be set aside in regions in which the disease prevails at all times.

As regards swine plague, the experiments which have thus far been carried out indicate that this disease may prove amenable to preventive inoculation. We have been able, by the injection of both living cultures and those sterilized at a low temperature (58° C.), to make the most susceptible animals, rabbits, insusceptible to the most virulent swine-plague bacteria. By two subcutaneous injections of cul-

tures of swine-plague bacteria, swine have been made insusceptible to doses injected into the circulation, which proved fatal to "control" pigs within twenty-four hours. In the preliminary experiments upon rabbits, designed to produce immunity, several methods were employed.*

(1) Minute but gradually increasing quantities of culture liquid of very attenuated swine-plague bacteria were injected at different intervals into the ear vein of rabbits. Only a very small proportion of these survived the test inoculation with very virulent swine-plague bacteria.

(2) Sterilized bouillon cultures were injected into the abdomen and into the circulation of rabbits. This method also produced immunity and partial resistance, but in only a comparatively few animals.

(3) The preceding method was modified in the following manner: Swine-plague bacteria from outbreak IX were allowed to produce for two days a rich growth upon agar. This growth was scraped off and a very turbid suspension of bouillon prepared and sterilized at 58° C. With this sterilized suspension injections were made into the abdomen of rabbits as follows:

Rabbit No.	May 4.	May 8.	May 14.	May 22.	Total.	Remarks.
	cc.	cc.	cc.	cc.	cc.	
35	1.5	1	2	3	7.5	Inoculated with virulent swine plague, May 26. Check dies over night. All three survive with considerable local reaction.
36	2	.5	2	3	7.5	
37	1	1.5	2	3	7.5	
38	.5	2	2	....	4.5	Inoculated with virulent swine plague, May 19; dies in 6 days with severe local reaction, pleuritis and pericarditis. The check dies in 16 to 20 hours.

These results show very decisively the protective effect of the sterilized growth of swine-plague bacteria. Additional experiments have not yet been made. In conjunction with Dr. Kilborne, the protective effect of swine-plague cultures was tested upon swine in the following experiment: Seven pigs belonging to the same lot and about four months old were chosen, three of which were set aside as "control" animals or checks. The remaining four received, February 28, 1891, a subcutaneous injection of 6 cubic centimeters of peptone-bouillon culture of virulent swine-plague bacteria, one-half into each thigh. As a result one died. The remaining three were reinoculated in the same way March 14, receiving on this date 10 cubic centimeters of culture liquid. April 3, these, together with the three control animals or checks, received the final test inoculation; 2 cubic centimeters of peptone-bouillon culture of the same bacteria were injected into a vein of the leg of each animal. Two of the control animals died within twenty-four hours, the third in thirty-six hours. None of the three vaccinated animals became ill. No symptoms of disease or lesions appeared subsequently.

These experiments simply demonstrate the fact that swine may be protected from fatal doses by subcutaneous injection. Whether this process would be successful in natural outbreaks can not be inferred from this test alone.

TEXAS FEVER.

During the past summer most of the available space at the Bureau Station was taken up with field experiments in Texas fever. The work in connection with this disease extended from the first week in July until the middle of November. The busiest season extended from the middle of August to the middle of September, during which time the disease makes its appearance in the exposed cattle. The field experiments were mainly directed by Dr. F. L. Kilborne, while the writer devoted himself to the study of the blood parasite of the diseased cattle and problems connected with the direct transmission of the disease from diseased to healthy cattle and other domesticated animals. In this work he was assisted by Dr. E. C. Schroeder, who did most of the counting of blood corpuscles—an indispensable process in determining whether exposed

* These experiments were carried out in conjunction with Dr. V. A. Moore.

animals have taken the disease or not. The study of preparations of blood obtained from diseased and healthy cattle has been continued in the laboratory more or less throughout the year.

In all thirty cases of Texas fever came under observation, of which seven died. The small percentage of fatal cases was very probably due in part to the coolness of the summer, in part to the fact that some of the animals had passed through the disease the previous year. In addition, a number of healthy animals were kept under observation as controls to the experiments. The investigations were directed mainly to the relation of ticks to the disease, although other problems were likewise under consideration, as will be seen below. The work consisted in taking the temperature and carefully examining the blood of the various cases from time to time to watch the beginning and the course of the disease in those exposed. This is absolutely necessary, otherwise nonfatal cases may entirely escape attention.

(1) The work of the past summer has again amply confirmed the work of previous summers, that the true cause of Texas fever is a microscopic parasite, belonging to the protozoa, which lives within the red blood corpuscles and destroys them. This protozoan has been detected in all cases of the disease coming under observation during the summer. In some instances the number of red corpuscles infected with this parasite in the kidneys, for example, was nearly 100 per cent. Bacteria have not been seen in any case unless post-mortem decomposition had begun. We therefore see no ground for the supposition that Texas fever is a bacterial disease, as has been maintained by Billings and Paquin, unless the disease studied by them in the West differs from the one produced at the experimental station by North Carolina and Texas cattle. Such an assumption is hardly allowable when we take into consideration the identity of symptoms and lesions.

(2) It has already been stated in the Report for 1890 that when ticks are hatched from eggs and placed on cattle they will produce Texas fever. This very important discovery was confirmed during the past summer by producing with young ticks the disease in three animals. One of these died, the others recovered after a time. Not only was the disease called forth in this way, but it was produced before the disease broke out in the field in which Southern and native cattle had mingled for some time. Thus the Southern and native cattle were placed in the same inclosure July 2, and the disease was first noticed August 22. The disease produced artificially by ticks alone in another inclosure appeared August 8. Both cattle and ticks were brought from North Carolina at the same time. The difference was due to the fact that in the one case the tick eggs were hatched artificially in the laboratory and thereby the process hastened.

During the winter of 1890–'91 a portion of one of the barns on the experiment station grounds was kept heated by means of a stove and the tick experiments continued. About six animals were used. A variable number of young ticks hatched in the laboratory were placed on these animals at different times. In all natives the disease was produced. In all but one it was exceedingly short and mild in duration. In this one the disease was identical with the nonfatal autumnal form of the disease, which differs clearly from the acute and usually fatal midsummer type, as will be shown in the detailed report. The object of these experiments was to determine whether cattle could not be subjected to a mild winter disease and thereby be made insusceptible. The results of the experiment did not, however, come up to our expectations.

In the work of the summer the question whether there are any other agents besides ticks which may convey the disease, being the most important of all under consideration, was again tested. The experiment consisted in picking ticks from Southern cattle before they were brought in contact with native cattle and afterward examining them every day to remove any which, in the first instance, had been too small to be detected. For this purpose Dr. Kilborne proceeded to North Carolina to procure suitable animals, and on their arrival no time was lost in removing the ticks and placing them with natives in the same inclosure. In 1889 a similar experiment had proved successful, *i. e.*, the exposed natives remained free from disease, but owing to the fact that the method of detecting very mild attacks by blood examination had not been fully worked out at that time it was highly desirable to try this experiment over again. A similar experiment was carried on in 1890, but it failed because the ticks had very probably been washed in from an adjoining more elevated field by the unusually heavy rains of the season. Last summer, also, the experiment was only partially successful for the reason that a few ticks had evidently escaped attention. On the exposed cattle a small number of ticks appeared in due time and two out of three took the disease. By carefully removing the small ticks from all three cases one animal was probably saved from infection, at least it did not take the disease. Of the two remaining, one finally died; the other recovered. While this experiment does not therefore prove that ticks are the only bearers of the infection, it is not opposed to this theory but rather in favor of it, as is shown by the experiment which had been going on in another field at the same time. In this field the ticks had not been removed from the Southern cattle, and as the young ticks appeared on the natives in due time in very large numbers, none of the exposed natives remained free from Texas fever.

(3) Can Texas fever be transmitted from sick to healthy cattle by direct inoculations? This question may now be answered in the affirmative. Last year blood from diseased cattle was injected directly into the jugular vein of two healthy animals. Subsequent examination indicated a mild attack of Texas fever, but the result was not positive enough. This year the blood of a diseased animal was injected into the jugular veins of three healthy animals, and in all a very acute form of Texas fever was produced within four or five days after the injection. One of these died, the others recovered. There can be no doubt, therefore, that the disease is inoculable when the germs are transferred quickly from the blood of one animal into the blood of another. As an illustration, a few brief notes of the fatal case are appended:

No. 186.—Cow 10 to 12 years old, from Maryland. Received on the station September 4, and placed in an unused field at some distance from the infected inclosures.

September 8.—Temperature 102. Red blood corpuscles, 4,980,700. Animal in good condition.

September 19.—After a careful examination of the blood, 14 cubic centimeters of blood, taken from the jugular vein of a cow affected with the disease, is injected into a jugular vein of this animal.

September 20.—Temperature 100.8.

September 21.—Temperature, 8 a. m., 100; 5 p. m., 103.

September 22.—Temperature, 8 a. m., 100.4; 5 p. m., 103.4.

September 23.—Temperature, 8 a. m., 102.6; 5 p. m., 104.7.

September 24.—Temperature, 8 a. m., 101.6; 6 p. m., 105.

September 25.—Temperature, 7:30 a. m., 104.3; 2:30 p. m., 106; pulse, 72; respiration, 78; red corpuscles, 4,761,900. Several large amœbiform parasites within corpuscles.

September 26.—Temperature, 7:30 a. m., 106; 2:30 p. m., 107; pulse, 96; respiration, 108; corpuscles, 4,330,000. Pairs of large amœbiform parasites within the corpuscles detected in both fresh and stained preparations of blood.

September 27.—Temperature, 6:30 a. m., 104.6; 6 p. m., 105.8.

September 28.—Temperature, 7:30 a. m., 102.2; 2:15 p. m., 101.2; pulse, 108; respiration, 60; corpuscles, 2,123,000. In one preparation fully 10 per cent of the corpuscles were infected with parasites. Animal exceedingly weak and trembling. Can scarcely remain standing. Falls and remains down, unable to rise. As the blood contained a considerable number of parasites, some was withdrawn from a jugular vein for the inoculation of some small animals. After this the cow went into convulsions and died a few minutes later.

At the autopsy the heart was found ecchymosed, the spleen very much enlarged and softened ($4\frac{9}{16}$ pounds), the liver enlarged, and occasional spots of bile injection visible on section. The bile was greatly thickened with flocculi and the urine contained hæmoglobin (red water). The parasites were present in the internal organs in large numbers. From cover-glass preparations the following estimates were made.

In blood from subcutaneous vein, 1 to 2 per cent of corpuscles infected.

In blood from right ventricle of heart, 1 to 2 per cent of corpuscles infected.

In blood from heart muscle itself (capillary blood), 30 to 50 per cent of corpuscles infected.

In blood from the spleen, 10 per cent of corpuscles infected.

In blood from the liver, 20 to 30 per cent of corpuscles infected.

In blood from the kidneys, nearly 100 per cent of corpuscles infected.

The parasites were chiefly in pairs.

(4) We have thus shown (1) that ticks placed on cattle soon after hatching produce Texas fever; (2) that blood taken from a sick native and injected into another native may produce the acute type of Texas fever without the intervention of ticks. In other words, the disease is inoculable from one native to another. The question next presents itself: Is the disease ever transmitted by natural agencies from Southern to native cattle and from sick to healthy natives without the aid of ticks? A full discussion of this important question would be premature at the present time, inasmuch as experimental evidence alone can solve the problem, and this is not yet forthcoming. It may, however, be excusable to say a few words on this phase of the subject, since the experimental work, being restricted to a few summer months, is necessarily slow in progress from year to year.

It is highly probable that the ticks are the only agents which carry Texas fever to Northern pastures. This is borne out by the long period of incubation (five to six weeks), which corresponds precisely to the time necessary for the development of a new generation of ticks. This was discussed in last year's report, and it was there pointed out that this long period was due to the fact that the mature ticks as they dropped on the pastures from Southern cattle laid their eggs, that these eggs hatched in from two to three weeks, according to the temperature, and that then the young attacked native cattle. The disease appears in from ten to fifteen days after the young ticks have attached themselves to native cattle. The production of a new generation of ticks necessarily demands four to five weeks, and thus corresponds to the original so-called period of incubation. The actual period of incubation, that is, the time elapsing between the infection of the blood by the tick and the first appearance of fever, is probably not more than five days.

When the disease has appeared in a herd, can any transmission of disease from sick natives take place? We have referred to this matter in the preceding report, and pointed out that sick natives with ticks on them may, after thirty or more days, infect pastures with a new generation of young ticks. But this usually pushes this infection into the late fall, and the disease thereby produced is mild and may pass unnoticed. But another question here presents itself: May the disease be transferred more speedily and directly than by means of young ticks from sick to healthy natives? This question is of little practical importance when the natives are all exposed in the original infected

field, as the young ticks are there all summer, and hence all cattle are likely to become infected sooner or later. But when diseased animals are taken from such infected fields and placed in noninfected inclosures, may healthy animals be infected directly from them? This infection must be considered possible through the agency of flies which pass from cow to cow, sucking their blood and thus inoculating the disease, because we have shown that the disease may be induced by the injection of diseased blood. But such mode of infection must be considered exceedingly rare, as we have observed it but once during the past three summers, and even in this instance the case is by no means clear.

In one of the inclosures on the experiment station, removed by a field and a lane from infected grounds, a number of head of cattle were kept as a reserve for experimental purposes. On September 29, over a month after the disease had appeared in the regularly infected pasture, a cow in this field died of undoubted Texas fever. This occurrence led at once to an examination of the blood and the temperature of the remaining animals in the field. Only one other was found infected. Upon this cow venesection had been practiced repeatedly early in the summer to elucidate some questions bearing on the blood in Texas fever, and she had been examined September 8 and found healthy. No ticks could be found on the animals in the inclosure. Here seems to have been a transmission of Texas fever without ticks. How the disease was transmitted will of course never be known. It is possible that flies may have passed rapidly from one field to another carrying the infection on their mouth-parts and inserting it into the vessels of the skin of healthy animals. This mode of infection from one field to another is regarded as very rare by those who have had occasion to watch the disease.

It will thus be seen that the facts are greatly in favor of the tick as the sole agent in the transmission of disease from the permanently infected regions of the South to Northern pastures. This will be still clearer when the subject is more fully presented with the experimental evidence. Meanwhile it would be unwise to deny the possibility of occasional infection of Northern animals mingling with those from the South through the agency of flies, etc., when there are infected and diseased animals in the Southern herd. Such transmissions would not affect pastures, but only the animals accidentally infected.

(5) That ticks may live through mild winters in protected localities and give rise to disease in the following summer without any fresh importations from the South was demonstrated on the station during the past summer. This is an exceedingly interesting and important point for latitudes whose climate resembles that of Washington, and should not be lost sight of by those who may be investigating the source of any particular infection. In September of 1890 ticks hatched in the laboratory were placed on two cows in a piece of woodland belonging to the station, but some distance removed from it. These contracted the disease in due time. One died during the acute attack, the other succumbed after it. The ticks matured from this case wintered over probably among the leaves under the trees, and on September 1 of the past summer one young animal was found with many ticks attached to it, and the examination of the blood demonstrated Texas fever. The other animals in the inclosure were insusceptible Southern animals kept over from previous years, but likewise infested with ticks. Since it is quite impossible that any ticks could have been taken to this inclosure during the past summer, the explanation given above is the only admissible one.

The practical lessons to be drawn from these experiments will be more fully discussed in the special report, as they will be more easily understood when accompanied by illustrations. Meanwhile we would caution against the Southern cattle tick and against all manure from

Southern cattle cars in midsummer. When any suspicion exists that the disease has invaded a herd, which is at once detected by a high evening temperature (104° to 107° F.), the herd should immediately be transferred to another pasture. This change, while it may not save all animals, will nevertheless be of some help. The danger that these cattle may infect other healthy stock later on in the season is very slight, excepting when the disease originally appeared very early in summer.

It is to be hoped that during the coming season we may be able to investigate methods of treatment of diseased cattle, and also the means by which ticks may be removed from Southern cattle.

PNEUMONIA IN CATTLE.

During the past two years a number of diseased lungs from cattle have been examined at the laboratory. These came from different localities, many of them sent by inspectors of the Bureau. In summer but few arrived here in any satisfactory condition, and in the most important earlier cases only portions of the entire lungs were received. Several of these cases were subjected to microscopical and bacteriological examination, chiefly for the purpose of making a diagnosis and also of studying forms of pneumonia in cattle which require more than the usual care and skill in bringing out points of difference between ordinary pneumonia and the contagious pleuro-pneumonia. In the Report for 1889 (p. 92), a brief statement was made concerning several cases investigated in that and previous years which might have been mistaken for pleuro-pneumonia, but in which bacteria were encountered which are probably the real cause of the disease.

In the cases studied in 1890 and 1891 there were detected the same bacteria previously encountered. The character and appearance of the lung disease, however, varied considerably in the different cases. These differences will be brought out in detail in another report. The bacteria did not differ materially from swine-plague bacteria, excepting in a few minor details, and we are safe in asserting that there are kinds of pneumonia in cattle caused by bacteria closely resembling those of swine plague and belonging to the same group.

There was no difficulty in distinguishing such disease from pleuro-pneumonia without resorting to microscopic or bacteriological tests. There will, nevertheless, remain some uncertainty about the diagnosis of pleuro-pneumonia so long as the cause has not been determined. Hence the necessity of investigating all forms of pneumonia in cattle which may be confounded with contagious pleuro-pneumonia, so as to reduce errors in diagnosis concerning this plague to a minimum.

EXPERIMENTS WITH THE MILK OF TUBERCULOUS CATTLE.

It has been known for some years that the milk of cows suffering from tuberculosis may contain tubercle bacilli. These bacilli, consumed by infants and children in the milk, may lead to tuberculosis or consumption in one or more of its numerous forms. It has been the object of investigators both in the medical and veterinary professions to find out precisely under what conditions the milk from tuberculous cows may be dangerous. One class maintain that only when the udder becomes the seat of tuberculous changes do the specific bacilli pass into the milk. Another class hold that when a cow is affected with tuberculosis to an advanced degree tubercle bacilli may pass into the milk even when the udder remains free from disease. In the Report for 1889 (p. 105), the question is summed up by giving briefly the results of

investigations up to that date. Since then the problem has not been materially changed, and it is obvious that only by collecting a large amount of material can we state positively under what conditions milk should be considered unfit for human food. During the year it was our good fortune to obtain two Jersey cows from a herd in the District of Columbia which were markedly affected with tuberculosis. The milk of these cows was tested for tubercle bacilli, as is shown in the following brief summary:

The cows (Nos. 155, 156) were received February 28, 1891. March 18 two guinea-pigs were inoculated with the milk of each cow, 5 cubic centimeters (or one-sixth ounce) being injected into the abdominal cavity of each animal. At the same time two young pigs were being fed with the milk daily. April 4 four fresh guinea-pigs were inoculated, two with the milk of each cow.

Cow No. 156 died June 5, with extensive generalized tuberculosis. The udder was carefully examined, but no tuberculous deposits could be detected. The four guinea-pigs were killed after a period ranging from one and one-half to four months after inoculation, but no trace of tuberculosis could be seen in any of them.

Cow No. 155 died June 24. The tuberculous changes were equally advanced, the udder intact. The four guinea-pigs inoculated with milk from this animal were equally free from tuberculosis. On June 22, two days before the death of this cow, two guinea-pigs were inoculated with the milk, which had by this time nearly given out. Both guinea-pigs were killed October 10. In one of these tuberculosis was present, but in a slight degree only, and the animal had grown fat and had failed to show the disease during life. The two pigs which had received the milk daily were killed, but no tuberculous lesions detected.

An examination of the above facts shows that after emaciation had begun in these animals, and from three to four months before they succumbed to advanced tuberculosis, no tubercle bacilli were present in the milk. In neither case was the udder found diseased after death. In one case several days before death, when the secretion of milk had almost ceased, a few tubercle bacilli were present. These two cases thus favor the position of those who maintain that tuberculosis of the udder is necessary to an infection of the milk when the disease is not too far advanced. When the animal has become greatly emaciated no self-respecting owner of such animal would use the milk that might still be secreted in small quantities.

Tuberculous deposits in the udder, when they have reached a certain size, can be detected during life. The most marked features of such disease have been described in the Report for 1889 (p. 102). When the tubercles are just beginning to form it may be wholly impossible to detect their presence during life by simple palpation of the bag. For this reason many condemn the milk of all cattle suffering from tuberculosis, because even if the udder is not visibly diseased tubercles may nevertheless be present.

The great importance of a regular periodical inspection of dairy cattle is thus made manifest. If only such animals in which the udder is found diseased would be condemned and the milk rejected a large amount of the injury presumably done by tubercle bacilli in milk could thereby be avoided. Those tuberculous animals in which the disease of the udder escapes attention because of its restricted character would be still liable to distribute tubercle bacilli, but only to a slight degree. Such inspection, if done by competent persons, would largely relieve the apprehensions of the public, which have been aroused by the extended discussion which this dread plague of tuberculosis has undergone in all journals in connection with Koch's lymph. All that can be done at present is to educate farmers and owners of herds of dairy cows in the vicinity of our large cities, where bovine tuberculosis chiefly exists, concerning the nature of tuberculosis and its

manifestations in cattle, and to make them aware of the great danger in the use of milk from cows which are beginning to emaciate or whose udders are diseased.

ABORTION IN MARES.

Early in March of 1890, Dr. Kilborne was directed to make an investigation of an outbreak of abortion among mares in a stud in Pennsylvania. From December to March there had occurred sixteen abortions among fifty-eight pregnant mares. Only one mare aborted during his visit, and from this two agar tubes were inoculated with vaginal secretion by means of platinum loops passed well up into the vagina several hours after the abortion.

In both tubes only one species of bacteria appeared within twenty-four hours. They were carefully studied by the writer and found to resemble closely hog-cholera bacilli in their form, size, and mode of growth on culture media. Their effect on small experimental animals, such as rabbits, could not be distinguished from that of weak or attenuated hog-cholera bacilli. There were a few minor differences which need not be detailed here. Suffice it to say that if this bacillus had been found in a hog-cholera outbreak the writer would have unquestionably considered it a variety of the hog-cholera bacillus. The presence of a pathogenic bacillus in connection with this disease made it necessary to determine whether this bacillus can produce abortion in pregnant mares experimentally. For this purpose cultures in bouillon were prepared and injected into the vagina of one pregnant mare and two pregnant cows by Dr. Kilborne. In all three cases a leucorrhœa or catarrhal discharge appeared one or two days after the injection and lasted several days. None of the animals aborted, however.

Another question needed solution. Is this bacillus commonly met with in the genital passages of pregnant and nonpregnant mares? If so, it probably has no significance. To determine this point agar cultures were inoculated by Dr. Kilborne from the vagina of five mares, one of them pregnant, and these were handed to Dr. V. A. Moore to determine whether the bacillus described was present. It could not be detected.

We can not come to any conclusion as to the relation of this bacillus to the disease in question until more cases have been investigated. On the one hand the disease-producing power of the bacillus, and its absence from the vagina under ordinary circumstances are in favor of our regarding it as the cause. On the other hand, the failure to produce the same result artificially upon a pregnant mare is opposed to its specific action. Yet even this experiment is by no means conclusive, since the bacilli may have lost some of their virulence, or the animal experimented on may have been in condition to resist the infection.

It is also desirable to call attention to the possibility of a conveyance of hog-cholera bacilli from diseased swine to pregnant mares. That such a possibility exists may be inferred from the foregoing observations. In fact, with our limited knowledge of animal diseases in general, it is safe to assume that infectious diseases may be transmitted from one species of animals to other species until experience has proved the contrary.

MISCELLANEOUS WORK.

In addition to the foregoing investigations, occasional examinations of disease among domesticated animals occurring in the District of Columbia which were brought to our notice were made. Such work included diseases among fowls supposed to be infectious and the inocu-

lation of guinea-pigs to make the diagnosis in cases of suspected glanders among horses.

In the early part of the year Dr. E. C. Schroeder was directed to make some investigations in Missouri of the so-called cornstalk disease. No satisfactory cases, however, came to his notice, so that no additional information was obtained of the nature of this disease. Dr. Schroeder also made a number of post-mortem examinations of swine which had succumbed to some infectious disease. From these cases both swine-plague and hog-cholera bacteria were isolated, thus indicating the existence of a mixed disease.*

INVESTIGATION OF THE EFFECTS OF BACTERIAL PRODUCTS IN THE PREVENTION OF DISEASES.

By Dr. E. A. v. Schweinitz.

A large part of the time during the past year has been occupied in preparing considerable quantities of the active bodies contained in the culture liquids of the hog-cholera and swine-plague germs, and in testing their effect, in conjunction with Dr. Kilborne, upon hogs, with reference to the production of immunity from disease.

A detailed account of the experiments upon guinea-pigs and the methods of making them immune to hog cholera were given in our last report, as well as some preliminary experiments in a similar line with the swine-plague albumose. A few more of the experiments upon guinea-pigs with the swine-plague germ may be added here.

Experiment 1.—Two guinea-pigs of about 1 pound in weight were treated by injecting beneath the skin of the inner side of the thigh a solution of suplagoalbumin in sterilized water. Each pig received 0.003 gram of the substance. A very slight swelling was noted at the point of injection. The animals, however, appeared quite well again in three or four days. Two checks and the two treated pigs were then inoculated with 0.001 cubic centimeter of peptonized beef broth swine-plague culture one day old. The checks died in thirty-six and forty-eight hours. The autopsies showed characteristic death from swine plague. The two treated pigs appeared ill for two days, but then recovered, so that a very complete immunity had here been produced.

In a second experiment with two treated animals and two checks similar results were obtained, the checks dying in three days and the treated animals being but slightly affected by the virus and finally recovering.

The five sets of experiments so far conducted had shown conclusively that very small quantities of the albumose, obtained from the cultures of the swine-plague germ, are sufficient to make guinea-pigs immune to the test dose of swine plague.

In order to determine if there was any relation between the immunity secured by the treatment for the two different diseases, the following experiments were conducted:

Two guinea-pigs that had been submitted to the preventive treatment for hog cholera were inoculated with 0.001 cubic centimeter of swine-plague culture one day old. Both animals died from swine plague within forty-eight hours.

In the reverse experiment, four guinea-pigs that had undergone the preventive treatment and recovered from an inoculation with swine plague, together with two checks, were inoculated with 0.1 cubic centimeter of hog-cholera culture one day old. The check animals died in nine and ten days respectively, the others in ten and

*See Special Report on Swine Plague, 1891, p. 82, for details.

eleven days, the autopsies showing characteristic hog-cholera lesions. These results show that in guinea-pigs the two diseases of hog cholera and swine plague are distinct and independent, and that immunity from the one disease leaves the animal still susceptible to the other.

Some parallel experiments on hogs, subsequently conducted at the station by Dr. Smith, showed that acquired immunity from the one disease did not protect the animals from the other.

It was now of interest to determine if guinea-pigs could be successfully treated and exposed to one disease, and after recovery treated and exposed to the second disease. Four sets of experiments were conducted.

In the first two sets, two guinea-pigs were treated with 0.006 gram of swine-plague albumose, and after a week exposed to the disease of swine plague, together with checks. The latter died, while the others recovered. They were then treated with 0.1 gram each of the hog-cholera product, and after some days exposed to the disease of hog cholera, with checks. Here again the checks died and the others recovered.

In the reverse experiment, the guinea-pigs were first treated for hog cholera and exposed, then for swine plague and exposed. In both instances the checks died, while the treated animals recovered.

The group of experiments showed conclusively the possibility of successive treatment and secured immunity with guinea-pigs.

Some of the chemical differences between the products of the two diseases may be referred to here. The swine-plague cultures yield on distillation with acid or alone both phenol and indol, the quantity of the latter depending upon the age of the culture. The hog-cholera cultures yield on distillation ammonia and methylamine, the products in solution thereby undergoing a partial decomposition. An analysis of the ash-free swine-plague albumose shows that it contains less nitrogen and carbon than the corresponding hog-cholera product. It is also more easily soluble in water, and is precipitated from this solution by alcohol; like the hog-cholera product, it does not dialyse.

SWINE-PLAGUE EXPERIMENTS UPON HOGS.

The experiments with the swine plague were next extended to hogs, to see if a practical immunity from disease could be secured in these animals by treating them with the extracted active principles of the sterile cultures.

The same manner of treatment as that used upon guinea-pigs was followed.

Four hogs, black Essex and Berkshire, were selected.

No.	Weight.	Age.
	Pounds.	*Months.*
410	40	3
411	40	3
412	45	3
413	40	3

Nos. 410 and 411 were treated, the other two reserved for checks.

On November 26, 1890, Nos. 410 and 411 were given a subcutaneous injection of 3½ cubic centimeters (0.2 gram) each of the solution of suplagoalbumin. There were no resulting ill effects from this injection, either in the general health of the animal or the production of a local lesion. On December 4, 1890, these two animals, and also the two

checks, were inoculated in the femoral vein with $1\frac{1}{4}$ cubic centimeters of peptonized beef infusion swine-plague culture one day old. Both of the checks, 412 and 413, died on December 5, fifteen hours after the inoculation. Autopsies showed death from swine plague. Of the treated animals, No. 410 was but slightly affected by the inoculation with the germ, and on December 9 appeared entirely recovered. No. 411, on the contrary, was very sick from the inoculation, had been down, unable to rise since December 7, and finally died on December 22, two weeks after the checks. The autopsy made by Dr. Smith was as follows:

The animal was greatly emaciated; weight only 28 pounds. There was an enlargement of both knee and hock joints, but the disease appeared to be confined to the joints only. Lungs show no inflammation or hepatization. Right heart filled with large dark clot; left with larger partially washed clot. Gall bladder distended with very thick bile, holding large quantities of solids in suspension. Liver more firm than normal. Stomach contracted; contains a very small quantity of viscid bile-stained liquid. Spleen not enlarged; pulp rather dark. Kidneys rather small; on section show fatty degeneration. Two rabbits, inoculated with pus from the knee joint dead in twenty-four hours; autopsy showed death from swine plague; cover-glass preparations from the spleen and liver showed swine-plague germs.

In the second experiment the exposure with the germ was not severe enough to kill the checks, hence no conclusions could be drawn. The third experiment was as follows:

Five hogs, black grade, were taken.

No.	Age.	Weight.
	Months.	*Pounds.*
466	3	55
467	3	50
456	3	50
457	3	40
458	3	45

Nos. 456, 457, and 458 served as checks. Nos. 466 and 467 were treated by a subcutaneous injection of 0.3 gram albumose for each animal on February 28, 1891. On April 3, 1891, all the pigs were inoculated intravenously with 2 cubic centimeters of peptonized beef broth swine-plague culture (No. 15) one day old.

Check No. 457 died April 4; check No. 458 died April 40; check No. 456 died April 5.

Treated pig No. 466 died April 4; No. 467 was made ill for two to three days by the inoculation, but by April 10 was entirely well. The autopsies upon the animals were made by Dr. Kilborne, and showed death from swine plague. The exposure with the virus in this case was a little too severe.

For the fourth experiment, pigs Nos. 492, 496, 499, and 500 were treated on May 12 by a subcutaneous injection of a water solution of 1 gram swine-plague albumose each. On May 4 pigs Nos. 493, 494, 497, and 498 were treated in the same way, with 0.7 gram of albumose each, and again on May 12 with 1 gram more of albumose each.

May 21 these eight animals and four checks were inoculated intravenously with $2\frac{1}{2}$ cubic centimeters of swine-plague culture. One check died May 22, the second check on May 25, and the third on July 6. The fourth check was quite sick from the inoculation for some time, but finally recovered.

One of the treated animals, No. 500 (one of the lot that had the smaller amount of albumose), was made ill by the inoculation, but recovered. Another one was killed by fighting, but autopsy showed no signs of death from swine plague. The other treated animals were but little affected by the inoculation and recovered quickly. The result was, therefore, that none of the treated animals died from the exposure. Three of the checks died and the fourth was very ill. Still another experiment was tried with five animals and five checks. The exposure with the virus, however, was not sufficiently severe to kill any of the checks, although the latter suffered a great deal more from the inoculation with the virus than the treated animals. The germ used for the inoculation had evidently become attenuated.

We can safely conclude from these experiments that hogs can be made immune by treatment with a fairly small dose of the albumose

obtained from the cultures of the swine-plague germ. This immunity is sufficient to protect the animal from an intravenous injection of virus which would kill the checks or nontreated animals in from forty-eight to seventy-two hours.

HOG CHOLERA.

The experiments upon hogs with the view of making them immune to the disease of hog cholera have also been continued. Some have been fruitless, owing to a too severe or too slight dose of virus for the exposure. Others have been only partially successful. One of these experiments may be recorded here:

No.	Weight.	Age.	No.	Weight.	Age.
	Pounds.	*Months.*		*Pounds.*	*Months.*
16	40	3½	24	50	3½
17	45	3½	25	40	2
18	40	3½	26	40	3
19	40	3½	27	40	3
20	55	3½	28	35	3
21	60	3½	29	35	3
22	55	3½	30	40	3
23	50	3½			

Nos. 16, 19, 23, 24, 25, and 28 were treated with the substance isolated from the cultures. Nos. 17, 20, 22, 29, and 30 were used as checks, and Nos. 18, 21, 26, and 27 were treated by two intravenous injections of a small quantity of the hog-cholera culture to serve as a check upon the severity of the final exposure.

On June 22 all of the pigs were inoculated in the vein with 5 cubic centimeters each of a peptonized beef broth hog-cholera culture two days old.

Of the checks, Nos. 30 and 29 died six days after the inoculation, and No. 22 twenty days after the inoculation.

No 27, one of the pigs which had been treated by an intravenous inoculation with small quantities of the germ, died nineteen days after the final exposure.

One of the treated animals, No. 28, died thirteen days after the exposure; the others were ill, but recovered nicely and are in good condition.

While not perfectly successful, it is fair to conclude that the treated animals were protected to some extent. Of the five checks three died. Of the four treated by intravenous injections one died, and of the six animals treated with the active extract from the cultures only one died.

We have hopes that this method can be further improved so as to make the pigs immune to the disease of hog cholera.

GLANDERS.

In December, 1890, a preliminary experiment with glanders cultures was made with the view of extracting from them an albumose, if such existed. Dr. Smith had prepared for me some acid glycerine peptonized beef broth media. After inoculation these flasks were allowed to stand at the temperature of the room, 26° C., for about two months. They were then heated for several hours at 80° C., and the filtered culture subjected to treatment with alcohol. In this way an albumose was obtained soluble in water, nondialysable, precipitated from its water solution by alcohol.

The effect of this albumose in producing immunity in guinea-pigs was tested. First one guinea-pig was treated by a subcutaneous injection of a solution of 0.01 gram of the albumose, and a few days afterwards two more guinea-pigs received 0.05 gram of albumose each. These injections caused inflammation and swelling, which disappeared in ten

days to two weeks. Forty days after this injection these animals and two checks were all inoculated by Dr. Kilborne at the station with a loop of a glycerine peptonized beef broth glanders culture. One of the checks died from glanders thirteen days after the inoculation. The one of the treated pigs that had the small dose of albumose died thirteen days and one of the other treated animals ten days after the inoculation. The second check did not die until three months after the inoculation. The third treated animal recovered. A second experiment in this line on a larger scale is at present being carried on. The effect of this substance as a means of diagnosis is also being tested.

An examination of some cornstalks sent from Missouri, supposed to have caused a disease of cattle, showed the presence of very small amounts of betain and cholin, but not in sufficient quantities to cause disease. The stalks as received were covered with smut. This was carefully separated before the examination of the stalks, and will be further examined.

REPORT OF THE CHEMIST.

SIR: I beg leave to submit herewith an abstract of the work of the Division of Chemistry during the year 1891.

Respectfully,

H. W. WILEY,
Chemist.

Hon. J. M. RUSK,
Secretary.

THE USE OF ALCOHOL IN THE MANUFACTURE OF SUGAR FROM SORGHUM.

To enable the Department to make a practical test of the method outlined last year for the use of alcohol in the manufacture of sugar, a grant of $25,000 was made by Congress. Medicine Lodge, Kans., was selected as the place for making these experiments. The climatic conditions of this place, as indicated by three years' experience, are favorable to the production of sorghum with a high content of sugar. The town is situated at the terminus of a branch of the Atchison, Topeka and Santa Fé Railroad, in Barber County, Kans., 340 miles southwest from Kansas City, and about 20 miles from the Indian Territory line. The prevailing soil is a reddish loam, very fertile, and producing large crops of all kinds of cereals when sufficient rain is supplied. The field for growing the cane for experimental purposes was leased from Miller & Benedict, and contains 39½ acres. It is situated on the north bank of Medicine River, 2 miles west of the village. The surface is practically level, being, however, slightly higher on the north side, affording excellent natural drainage in case of heavy storms of rain.

The field was platted by the county surveyor into sixteen blocks, each separated by an alley 10 feet in width. Eight of the blocks on the south side contain each 80,000 square feet. Of the remainder, seven in the north part of the field contain exactly 2 acres each, and the last one, in the extreme north end, 3 acres. The field was plowed in April to a depth of 8 or 9 inches, and the south half of it subsoiled to the depth of 6 inches. Planting commenced in the latter part of April and was nearly all completed by the 1st of May.

The seed from which the planting was made had been grown at the Department Experiment Station, at Sterling, during the season of 1890. The following varieties were planted: Early Amber, Folger's Early, Early Orange, Black African, Link's Hybrid, Undendebule No. 1, Australian, Variety 161, Variety 160, Colman, Variety 91, Variety 112, Alapore Jowar, Planter's Friend, India and Orange, Ubehlana.

The field received careful culture, and the season, on the whole, was favorable. The subsoiling enabled the crop to bear, without any injury whatever, the severe drought beginning in July and extending through the greater part of August. Beginning on the 14th of September, and continuing for three days, a sample was taken from each of the varieties grown, representing an aliquot part of an acre. The total weight of this sample was determined and likewise the weight of the seed tops and

leaves, giving, by difference, the weight of clean cane. Afterwards the seeds were thrashed and weighed.

The results, showing weight of whole cane, weight of blades and trash, weight of clean cane, and weight of dry seed, are given in the following table:

Per acre.

Variety.	Weight, whole cane.	Weight, blades and trash.	Weight, clean cane.	Weight of dry seed.
	Tons.	*Tons.*	*Tons.*	*Pounds.*
Folger's Early	13.96	1.67	10.07	2,340
Colman Cane	12.08	1.66	8.09	(*)
Link's Hybrid	10.72	1.26	7.67	(*)
Black African	13.17	1.48	9.17	1,093
Early Orange	14.54	1.64	9.86	1,937
Undendebule No. 1	16.36	1.88	11.48	1,304
Colman Cane (*bis.*)	14.78	1.68	11.51	2,384
Australian	11.09	0.97	8.61	1,768
No. 161	15.04	1.77	10.89	1,904
No. 160	11.06	1.03	8.38	1,196
No. 91	14.33	1.76	10.19	2,558
No. 126	10.01	1.39	7.01	1,166
No. 112	13.28	1.76	9.53	2,558
Planter's Friend	14.58	2.12	10.60	1,180
India and Orange	13.80	1.86	9.56	2,099
Ubehlana	13.65	1.65	9.77	1,399

*Not taken.

Concerning the two samples of Colman cane mentioned in the above table, they were taken from two different plats representing different parts of the field. The seed from the first plat was not saved. By some oversight the seed from the Link's Hybrid was also lost. In regard to the sample of Link's Hybrid, it is but fair to say that it was taken from a single row and not from the block which was planted in Link's Hybrid. The showing, therefore, is not fair, inasmuch as the plat of Link's Hybrid was fully equal, as far as appearance goes, to any other cane in the field.

The selections mentioned above extended from the 14th of September to the 19th, thus giving a comparison of all the varieties at the time when the earliest were quite ripe and the latest nearly so. The chief object of taking the samples at the time was to determine the comparative yield of all the varieties while they were still green and before frost had affected them. Nevertheless, it was decided also to determine the quantity of sugar in the juice of each variety.

The percentage of sugar in the juice, the number of stalks per acre, and the yield in sugar per acre, of each variety follow:

Variety.	Sugar in juice.	Number stalks per acre.	Sugar per acre.
	Per cent.		*Pounds.*
Folger's Early	15.75	(*)	2,745
Colman Cane	14.50	14,022	2,071
Link's Hybrid	13.10	11,434	1,758
Black African	12.95	15,253	2,090
Early Orange	10.20	17,533	1,767
Undendebule No. 1	13.75	24,339	3,021
Colman Cane (*bis.*)	14.10	20,935	2,670
Australian	14.55	11,147	2,104
No. 161	9.40	24,168	1,805
No. 160	12.10	15,561	1,995
No. 91	12.45	18,095	2,237
No. 126	16.25	13,959	2,294
No. 112	14.15	19,874	2,369
Planter's Friend	14.35	18,622	1,870
India and Orange	12.25	15,785	2,059
Ubehlana	12.00	17,392	2,090

*Not given.

From average determinations, which have been repeatedly made, it is found that the amount of sugar in the cane is about 88 per cent of that in the juice. The numbers in the above table, therefore, multiplied by 0.88, will give the actual quantity of sugar in the cane.

The column giving the number of stalks per acre is also interesting. In the case of Link's Hybrid, as has before been mentioned, there was a poor stand in the row which was taken for illustration, and this row shows the lowest number of stalks per acre. It will require longer experience to decide the point in regard to the proper number of plants per acre, and this number will doubtless vary for the different varieties of cane.

The Undendebule variety is a slender stalk with a small seed head, and would doubtless be able to carry more stalks per acre than the Early Orange or the Colman; nevertheless, it seems quite evident that in many instances a larger number of stalks could have been grown per acre without materially lessening the average weight of each stalk, or interfering with its content of sugar From present indications it may be said that there should not be less than 20,000 stalks per acre.

The yield of seed is also most gratifying. At 50 pounds per bushel many of the varieties have yielded over 40 bushels per acre, and, in one or two instances, 50 bushels, the lowest yield being slightly over 20 bushels per acre. The value, therefore, of sorghum as a cereal crop should not be without consideration, inasmuch as the food value of sorghum seed is almost if not quite equal to that of maize. When the greater certainty of the crop is considered, especially when grown in the semiarid regions, its value as a food crop is certainly equal to that of maize. There is, of course, but little demand for sorghum seed as a food supply at the present time, but its growth in large quantities would doubtless create a market in which it would find a profitable sale.

The column showing the yield of sugar per acre indicates, of course, the total sugar grown and not the amount which could be recovered. Up to the present season the recovery of 33 per cent of the total sugar in the sorghum crop has been regarded as a good manufacturing yield. Thus the actual yield per acre of commercial sugar would be one-third of the quantity given in the table. By improved processes of manufacture, however, the rate of yield has been raised to 60 per cent and even 65 per cent, and there is little doubt of the fact that it can, within a year or two, be made to reach 70 per cent. The actual quantity of sugar, therefore, which it may now be said can be obtained per acre would be two-thirds of the quantity given in the table. In some instances it is seen that this would amount to fully 1 ton of sugar per acre. At 2½ cents a pound, a ton of sugar would be worth $50, and this must be regarded as a very satisfactory financial return when the other elements of the crop are taken into consideration.

MANUFACTURING PART.

As explained in the report of last year, alcohol of 95 per cent strength is found to precipitate almost completely certain gummy and amorphous substances present in sirup made from sorghum containing from 50 to 55 per cent of solid matter, or, as is commonly said, sirup of from 50° to 55° Brix. For the purpose of testing this process in a commercial way, a small experimental factory was built at Medicine Lodge, Kans. The contract for building this factory was let to the Fort Scott Foundry and Machine Works Company. Preliminary trials were made

of the machinery early in September, but many defects had to be corrected before actual work could begin. The necessary changes and alterations in the machinery occupied the time fully until early in October. The capacity of the house was calculated so as to be able to work 1 ton of cane per hour. The actual capacity, however, was found to be greater than this, and, after all the adjustments were made, it was found that 1½ tons per hour could be easily handled. In addition to the ordinary machinery for manufacturing sugar, there was erected, in connection with the establishment, a still for the purpose of recovering the alcohol used in precipitating the gummy and amorphous substances from the sirup. This still was built by Klingel Bros., of Peoria, Ill. It was 2 feet in diameter, 25 feet high, and had a capacity of furnishing 1,000 gallons of 95 per cent alcohol per day.

The method of treating the cane was as follows:

It was first cut into pieces 1 inch in length by an ensilage cutter. These pieces were next passed through a fanning apparatus for the purpose of removing the leaves and trash. The clean pieces of cane then passed to a shredding machine, in which they were cut into very small pieces, almost a pulp. The pulp passed next to the diffusion battery, where the sugar was extracted. The diffusion juice was collected in clarifying tanks, treated with lime, and the skimmings removed. Instead of sending the skimmings through a filter press, as would be ordinarily done in a sugar factory, on account of their small quantity they were collected in a separate tank and reclarified, only the heavy scums and sediment being thrown away. The juice, after clarifying, was concentrated to sirup in a triple-effect evaporating apparatus. The density of this sirup was made to register 50° to 55° Brix. The sirups were collected in precipitating tanks, in which they were treated with an equal volume of 95 per cent alcohol and thoroughly mixed. The precipitated gums were separated by passing through a filter press, forming, for the most part, hard firm cakes containing only a small quantity of alcohol and sugar. The filtered sirup was next passed through the still for the purpose of recovering the alcohol. As soon as the alcohol was separated the sirup was boiled to sugar in a vacuum strike pan and dried in a centrifugal. No attempt was made to make refined sugar, only raw sugar being made.

Considering the fact that it was the first attempt ever made at work of this kind, it must be admitted that the apparatus worked smoothly and effectually, although many points were noticed where improvements could be made in details.

A summary of the results obtained with some of the varieties worked follows:

Colman Cane.—22.44 tons of Colman cane were delivered from the field, representing 17.47 tons of clean cane. The sirup was divided into two portions: the first portion boiled without treatment with alcohol, marked *a*, and the second portion boiled after treatment with alcohol, marked *b*. The first portion yielded 1,370 pounds of first sugar and 375 pounds of second sugar, being 156.8 pounds of first sugar and 199.7 pounds of first and second sugar per ton. The second part treated with alcohol yielded 1,330 pounds of first sugar, equivalent to 152.3 pounds per ton. The amount of second sugar was not determined. Apparently, from the above data, the untreated portion—that is, the portion treated by the ordinary process—yielded more sugar than that treated with alcohol, but this is only in appearance. The sirup boiled without treatment it was found could not be passed through the centrifugals although it was grained in the pan. The pan, however, being small, the grain was very fine, and this, combined with the gums, etc., present, made it impossible to pass it through the centrifugals. It was therefore placed in the hot room and allowed to stand a long while before being dried. The sugar obtained was of low polarization. On the other hand, the part which was treated with alcohol grained beautifully in the pan and was carried directly to the centrifugal, where it was dried in a very few

minutes, working as nicely in the machine as any massecuite could possibly have done from sugar cane grown in Louisiana or Cuba. There is, however, a considerable loss of sugar in the filter presses and in the still, which could not possibly be avoided in working in a small way. In addition to this the sirup boiled so freely in the pan that a considerable part was projected into the throat and carried over by entrainment. This was not the case with the sugar boiled in the ordinary way, which was sticky and was not projected into the throat of the pan. Calculated to pure sugar, the amounts of first sugar yielded by the two portions were: *a* portion, 132 pounds per ton; *b* portion, 142.7 pounds per ton. The percentage of sugar in the cane obtained as merchantable sugar, on the first portion, was 65.52. Unfortunately, in boiling for seconds from the alcohol portion, the proof was allowed to become too dense, and the result was that the massecuite was almost in the form of taffy. On account of this the sugar did not separate, and no seconds were made from the alcohol run.

The above rather minute description has been given of the run with the Colman cane, inasmuch as it represents the best cane worked, and the results are the most favorable.

Early Orange.—8.65 tons of Early Orange were worked, both by the *a* and *b* methods. The yield by the *a* method was 138.9 pounds of raw sugar, representing 54.93 per cent of the sugar in the cane. The yield by the alcohol method was 156 pounds of raw sugar, representing 67.70 per cent of the sugar in the cane. Calculated to pure sugar, the yield by the *a* method was 118.6 pounds per ton and by the alcohol method 146.2 pounds per ton.

Link's Hybrid.—9.77 tons of Link's Hybrid were worked by each of the methods given. Method *a* yielded 140.6 pounds of raw sugar, equivalent to 116 pounds of pure sugar per ton; worked by the alcohol method the yield was 148.7 pounds of raw sugar, equivalent to 139.6 pounds of pure sugar per ton. By the *a* method, the sugar recovered was 47.69 per cent of the sugar in the cane; by the *b* method, 61.47 per cent of the sugar in the cane.

Undendebule.—8.66 tons of Undendebule were worked by each of the methods. Method *a* gave 105.7 pounds of raw sugar, equivalent to 93 pounds of pure sugar per ton, equal to 35.18 per cent of the sugar in the cane. Worked by the *b* method the yield was 151.2 pounds of raw sugar, equivalent to 133.4 pounds of pure sugar per ton, or 50.45 per cent of sugar in the cane.

Varieties 112 and 91.—9.28 tons of the mixed varieties were worked by each of the methods. By the *a* method the yield was 130.5 pounds of raw sugar, equivalent to 107.5 pounds of pure sugar per ton, or 47.73 per cent of the sugar in the cane. Worked by the *b* method the yield was 140.3 pounds of raw sugar, equivalent to 131.3 pounds of pure sugar per ton, or 58.30 per cent of the sugar in the cane.

These results are all given on the yield of first sugars alone. In every case it was found impossible to dry the first sugars made by the *a* method until after they had stood for some time in the hot room; while in every case the sugars made by the alcohol method were passed at once through the centrifugal, yielding a fine grade of raw sugar.

In spite of the constant losses attending the alcohol method, which are easily avoided in working in a large way, it is found that the yield of sugar is uniformly very much higher, amounting to from 15 per cent to 20 per cent on the total sugar in the cane. In addition to this, however, it should be stated that the ease with which this sugar is worked would probably compensate for the increased cost, even if no more sugar per ton were made. In many cases it was possible to dry a full charge of sugar in two or three minutes instead of having to run the centrifugal for half an hour, as is usually the case with sugar worked in the ordinary way. The loss of alcohol was extremely small, none of it being found in the sugar, and the only loss being in the filter presses, where, of course, a small loss is unavoidable.

In general, it may be said that the results were satisfactory, although the work revealed many points where improvements could be made to render it more effectual and economical. Full details of the manufacturing operations will be found in Bulletin No. 32.

CULTURE EXPERIMENTS WITH SORGHUM AT STERLING.

The culture experiments of former years were continued at Sterling during the year 1891, with the same general purpose and methods. Quite a number of small plats of land were leased and planted with varieties, the selection of the growth of 1890. Six hundred plats were planted with seed grown in 1890; 31 plats were planted with seed received from foreign countries; 33 plats, containing nearly one acre each, were planted with varieties which had given best results in previous years. The object of planting these large plats was to get an average value of each, and to supply an ample quantity of seed of the best varieties for distribution. Seventy-two plats were planted in crosses of those grown in former years and considered worthy of further trial.

It was noticed that on clayey soil the cane did remarkably well in wet weather, but did not stand the drought well; while those varieties planted on sandy soil remained vigorous during August and September, which were dry months; June and July, on the contrary, being very wet for Kansas.

There are from 20,000 to 30,000 seeds in a pound of sorghum. Two pounds per acre, therefore, ought to give a very vigorous stand. About 2 pounds were used in planting the plats at Sterling. It has been observed that canes which are too close together suffer most from drought, while an increased tonnage is not secured by the thick planting. In general, it may be said of the crop at Sterling that the tonnage was large and the average quality of the juice good, but the season of maturing was somewhat delayed.

In all, 2,672 analyses of sorghum juice were made at the station, and for seed selection 26,635 polarizations of the juice from single canes were made. These 26,635 samples were selected from about 100,000 canes that were ground separately, but three-fourths of the number ground were rejected on account of showing low specific gravity. In all, 26,635 seed heads were selected as the result of the first polarization. From this number 7,827 were taken whose juice had a mean value of 15.98 per cent sucrose, with a purity of 73.78. From these a fourth selection was made of 1,768, whose juice had a mean value of 16.41 sucrose and 76.84 purity. Of the whole number of 26,635 selections, 5,905 contained between 15 and 16 per cent of sucrose, 5,296 contained between 16 per cent and 17 per cent, 2,550 contained between 17 per cent and 18 per cent, 172 contained between 18 per cent and 19 per cent, and 23 had 19 per cent and over. In general, the largest canes of the best varieties were selected in the field, and the small canes were thrown out by a second selection at the mill. In this way selections of seed were made, first from the best varieties, second from the largest canes, and in the third place from those which showed the highest percentage of sugar and high purity.

The varieties which have shown the best results at the Sterling Station, in the order named, are: (1) Australian (McLean); (2) Undendebule (Collier); (3) Colman; (4) Planter's Friend; (5) Folger's Cane. It must be remembered, however, that they are based solely upon analysis and not upon actual working in the sugarhouse.

The results of four years' experimental work would tend to show that sorghum is as stable in quality as other plants are; that the varieties have definite qualities of juice, which may be regarded as belonging to them and which are characteristic of them; and that the best

varieties, under climatic conditions similar to those of this station, with good cultivation, will yield canes which will have on an average 14 per cent of sugar in the juice, or a little over 12 per cent in the cane itself, producing about 240 pounds of sugar to the ton.

As was shown at Medicine Lodge, it is possible now to get 65 per cent of the sugar in the cane, which would give a yield, with such cane as indicated, of 156 pounds per ton.

Early Amber.—The mean composition of this cane for four years is as follows: Sucrose, 11.36 per cent; reducing sugar, 1.70 per cent, with a purity of 68.78.

Australian Cane.—This cane it is proposed to call McLean, on account of having been received from Hon. Peter McLean, undersecretary of agriculture of Queensland, in 1890. It has given the best results of any other variety for the two years in which it has been grown. It matures rather early, and will, perhaps, be suitable for growing a little farther north than most others. The canes are tall and rather slender, but withstand the winds as well as any of the varieties noted. The mean value for the two years of this variety is: Sucrose, 15.30 per cent; glucose, 0.62 per cent, with a purity of 75.09.

Colman Cane.—The mean value of Colman cane for three years shows 14.24 per cent sucrose, 1.05 per cent glucose, with a purity of 75.05.

Collier Cane.—The seed of this cane was furnished the station by Dr. Peter Collier, of Geneva, N. Y., under the name of Undendebule No. 1. In recognition of the great service of Dr. Collier to the sorghum-sugar industry it is proposed to call it by his name. The mean value of this cane for four years shows 14.29 per cent sucrose, 0.72 per cent glucose, with a purity of 72.90.

Folger's Cane.—The mean value of this cane for three years shows 13.50 per cent sucrose, 1.84 per cent glucose, with a purity of 73.60.

Planter's Friend.—The mean value of this cane for four years shows 14.45 per cent sucrose, 1.31 per cent glucose, with a purity of 73.54.

Variety No. 112.—The mean value of this variety for three years shows 14.06 per cent sucrose, 0.99 per cent glucose, with a purity of 74.51.

Variety No. 161.—The mean value of this variety for three years shows 13.40 per cent sucrose, 0.66 per cent glucose, and 74.83 purity.

Early Orange.—The mean value of this cane for four years shows 12.17 per cent sucrose, 2.34 per cent glucose, with a purity of 68.08.

Detailed information in regard to further work at the Sterling Station will be found in Bulletin No. 32.

The importance of the work at this station can scarcely be estimated in relation to practical results in the manufacture of sugar from sorghum. It appears that by the systematic methods of selecting varieties it is possible to develop qualities in sorghum cane which will permit of its taking its place in the same rank with sugar cane and sugar beets as a source of the sugar supply of the world. The remarkable progress which has been made for four years is a sufficient justification for the continuance of the work in practically the same lines of investigation. It would not be reasonable to expect a continuance of the rapid improvement in the quality of the cane which the first four years of the work has shown. The chief expectation of the future must be in establishing firmly the good qualities of the different varieties, and in the gradual but slow improvement of these qualities.

It seems at the present time that little would be required in addition to the production of cane as rich in sugar-producing qualities as some of those which have been grown at the Sterling Station, but these qualities must be so well established as to enable the planter to depend

upon them from year to year for field culture. That much has been done in this direction is shown by the results at the Medicine Lodge Station during the present year, where large plats of cane showed the same good qualities in the factory which they had previously disclosed in the laboratory.

EXPERIMENTS WITH SUGAR BEETS.

For the purpose of promoting the culture of sugar beets, looking to the manufacture of sugar, an experiment station was established in the State of Nebraska, at Schuyler. Thirty acres of land were leased in the early winter and prepared for planting in the spring. The intention of taking so large a field was to permit the practice of systematic rotation with the object of having the same plat of land in beets only once in four years. This would give 7½ acres for the planting of each year. The experimental field is located near the junction of the Shell Creek Valley with the Platte River Valley. It is about 6 miles north of the Platte River, and is protected on the north and west by a range of hills about 50 feet high. The soil of the field is a dark loam about 2½ feet in depth. This rests upon about 1½ feet of clay and sand, gradually merging into a fine sand to a depth of about 5 feet. It is a loose porous soil of excellent quality.

The field selected for the beets had not been in previous cultivation, but had been used as a pasture for many years. A field which had been previously tilled would have been preferred for the purposes of our work, but it was found difficult to get such a field in a suitable location. For the purpose, however, of testing soil previously cultivated, a part of the planting was made in a different field which had been several years in cultivation, but with a northern instead of a southern exposure.

The seed bed was prepared as early in the spring as the weather would permit, by plowing to the depth of 8 or 9 inches and subsoiling to the depth of 5 or 6 inches. The surface of the soil was placed in proper tilth by harrowing and rolling, and the field was ready for planting in the latter part of April and the 1st of May.

The north field was planted beginning on the 29th of April. The seed was put in with a drill from 1 inch to 1½ inches in depth. The seed was planted in rows 17 inches apart, and at the rate of 15 to 20 pounds per acre. After planting the ground was rolled. Six varieties were planted, viz: (1) Klein Wanzlebener, furnished by Dippe Bros., of Quedlinburg; (2) White Improved, furnished by Vilmorin & Co., Paris; (3) Desprez variety; (4) Variety from Lemaire; (5) Variety furnished by Knauer; (6) Klein Wanzlebener Elite.

The plats in the south field, viz, the regular station field, were planted on the 5th and 6th of May. The whole month of May remained quite dry, and the seeds germinated poorly. Rains in June, however, brought the beets on rapidly and necessitated thinning, which was completed in all the plats by June 18.

The cultivation of the beets consisted simply in keeping the surface of the ground in good tilth and preventing the growth of weeds. It was accomplished jointly by horse and hand hoes. A good stand of beets was secured on all the plats, and the months of June and July were especially favorable to a rapid and vigorous growth of the plants. By the time of the accession of dry weather in August they had secured such a hold as to enable them to bear the drought of that month without much injury. From September 23 to October 8 measured plats of the different varieties were harvested in order to determine the comparative

yield per acre. Three square rods of each variety were gathered for this purpose. The weight of beets per acre was as follows:

	Tons.
Klein Wanzlebener Elite	20.56
Knauer	21.28
Lemaire	23.49
Desprez	26.42
Vilmorin	25.80
Klein Wanzlebener	24.60

In the north field the yield per acre was as follows:

	Tons.
Klein Wanzlebener Elite	18.10
Knauer	17.7
Lemaire	18.4
Desprez	21.2
Vilmorin	21.1
Klein Wanzlebener	22.5

The analyses of the samples of beets were commenced on the 15th of September, and consisted in examining a large number of beets individually and then in lots of ten, taking all the beets as they came. In this way a strict average comparison of the beets could be obtained. The varieties examined at different times show the influence of ripening or decay upon the content of sugar. The results of the various examinations are found in the following table:

Field A.

Variety.	Date.	Sucrose in juice.	Purity.
		Per cent.	
Klein Wanzlebener Elite	Sept. 12	12.6	75.9
	Oct. 13	14.5	84.6
	Oct. 31	14.2	83.9
Knauer	Sept. 12	11.5	75.7
	Oct. 14	14.8	88.0
	Nov. 2	13.2	82.1
Lemaire	Sept. 12	11.5	77.2
	Oct. 15	14.1	83.5
	Nov. 2	12.6	80.0
Desprez	Sept. 12	13.2	76.7
	Oct. 16	14.4	84.6
	Nov. 2	12.6	80.9
Vilmorin	Sept. 12	13.1	76.3
	Oct. 17	14.6	84.9
	Nov. 2	13.1	83.6
Klein Wanzlebener	Sept. 12	13.6	77.7
	Oct. 19	14.5	82.8
	Nov. 2	13.0	79.7

Field B.

Variety.	Date.	Sucrose in juice.	Purity.
		Per cent.	
Klein Wanzlebener Elite	Sept. 15	14.6	82.0
	Sept. 21	15.7	84.6
Knauer	Sept. 15	15.7	80.2
	Sept. 22	15.4	84.9
Lemaire	Sept. 15	13.2	77.0
	Sept. 26	13.8	81.2
	Oct. 20	14.6	88.5
Desprez	Sept. 15	13.8	81.3
	Oct. 6	13.5	....
	Oct. 21	14.1	87.7
Vilmorin	Sept. 15	14.3	....
	Oct. 8	13.8	....
	Oct. 22	13.4	85.8
Klein Wanzlebener	Sept. 15	14.7	....
	Oct. 10	14.7	....
	Oct. 23	14.1	83.8

The quantity of sugar produced per acre by the different varieties in the two fields is given in the following tables:

Field A.

Variety.	Weight per acre.	Sucrose in beets.	Sugar per acre.
	Tons.	*Per cent.*	*Pounds.*
Klein Wanzlebener Elite	18.1	13.8	5,001
Knauer	17.7	14.0	4,945
Lemaire	18.4	13.4	4,924
Desprez	21.3	13.7	5,837
Vilmorin	21.1	13.9	5,855
Klein Wanzlebener	22.5	13.8	6,204

Field B.

Klein Wanzlebener Elite	20.56	14.9	6,126
Knauer	21.28	14.9	6,341
Lemaire	23.49	13.8	6,473
Desprez	26.40	13.4	7,081
Vilmorin	25.80	13.9	6,838
Klein Wanzlebener	24.60	13.9	6,838

It was to be expected, from well-known facts connected with beet culture, that the growing of beets on practically virgin soil would tend to increase the tonnage per acre at the expense of the sugar content of the beets. It is gratifying, however, to see from the above results that the average content of sugar in the beets has been very little diminished by the increased tonnage. It should be remarked, however, that this increased tonnage is due to the fact that the beets were grown very closely together, and thus kept from becoming very large. In fact, the average weight of the beets grown upon the station is much less than it should be, but it was thought best to secure this result rather than to have overgrown beets with a low content of sugar.

It will be of interest to compare the results obtained at the station during its first year with the average results obtained in field culture in the beet-sugar countries of Europe. It will be understood, of course, that this is hardly a fair comparison, but it shows that with careful culture, even on the strong virgin soils of this country, the record of tonnage and saccharine strength compares very favorably with the general results obtained in field culture in Europe.

The full details of the work of the experiment station will be given in Bulletin No. 33, now in course of preparation.

YIELD OF BEETS PER TON—PERCENTAGE OF YIELD OF SUGAR IN BEETS IN EUROPE COMPARED WITH THE RESULTS OBTAINED AT SCHUYLER.

In respect of the tonnage of beets per acre and the average content of sugar in the beet for the different countries of Europe, it is difficult to give definite statements. The yield given in the official reports is the percentage of sugar obtained on the weight of the beet. We may safely assume, however, that between 80 and 85 per cent of the total weight of sugar in the beet is recovered in the process of manufacture. In regard to the tonnage per acre, the most reliable statements which we have access to give the following:

For the season of 1890-'91.

Austria-Hungary	tons per acre	9.8
France	do	11.3
Germany	do	13.8

The yield on the experiment station of the Department at Schuyler, Nebr., during the past summer, average of all plats, was 21.7 tons per acre. In explanation of this, however, it should be said that the soil on which these beets were grown was practically a virgin soil, very fertile, and, therefore, the yield must be regarded as abnormally high. It is not infrequent, however, in Europe, to obtain 20 and even 25 tons per acre in exceptional circumstances, but this is not obtained in the beet fields taken as a whole. It is thought, however, that with the natural fertility of the soil of this country we may expect, when rational agriculture is introduced and with proper artificial fertilizers, to obtain an average yield of from 16 to 17 tons per acre.

In regard to the content of sugar in the beets, the following statements can be made:

The percentage of sugar obtained in Austria-Hungary during the season of 1890-'91 on the weight of beets secured was 11.02. Assuming that 80 per cent of the total weight of sugar in the beet was obtained, it would make the per cent of sugar in the beet 13.7.

The yield of sugar in France during the campaign of 1890-'91 on the weight of the beets worked was 11.61 per cent, which, on the same basis, would give the percentage of sugar in the beet 14.05.

The percentage of yield in Germany during the season of 1889-'90 was 12.35. Allowing as before 80 per cent of the sugar in the beets to be obtained, this would give the percentage of sugar in the beet 15.4. The yield of sugar for the campaign of 1890-'91 is stated to be practically the same.

The percentage of sugar in the beets grown by the Department at Schuyler was 13.8.

It is probable that a nearer value of the real content of sugar in the beets in Europe, calculated on the percentage of yield, would be obtained by using the factor 85 instead of 80. Calculated on this basis, the percentages would be as follows:

	Per cent.
Austria-Hungary	12.9
France	13.6
Germany	14.5

Collecting the above into tabular form, we have the following comparative statements:

	Tons per acre.	Sugar in beet on 80 per cent basis.	Sugar in beet on 85 per cent basis.
Austria-Hungary	9.8	13.7	12.9
France	11.3	14.5	13.6
Germany	13.8	15.4	14.5
Schuyler	21.7	Per cent sugar in beet 13.8.	

GROWTH OF SUGAR BEETS IN DIFFERENT PARTS OF THE COUNTRY.

In order to comply with a general demand for experimental work with sugar beets, 5½ tons of seed were purchased for general distribution. Two tons of this seed were purchased from Dippe Bros., of Quedlinburg, of the Klein Wanzlebener variety; two tons were purchased from Vilmorin, Andrieux et Cie, of Paris, of Vilmorin's Improved variety, and 1½ tons were purchased from the Oxnard Beet Sugar Company, of Grand Island, Nebr., of German and French sugar-beet seed.

These seeds were put up in packages averaging 13 ounces to a package, making in all 13,500 packages, and were sent to 4,600 persons. At the same time there was sent to each person receiving seed a copy of Farmers' Bulletin No. 3, giving instructions for the planting and cultivation of the beets. This bulletin is still available for distribution to those who write for it. Full directions were also sent for sampling the beets and sending them to the Department for analysis. The mean results obtained for each State are as follows:

Table showing mean composition of beets in each State, based on the average composition by counties.

State.	Samples.	Sucrose in beet.	Purity.	State.	Samples.	Sucrose in beet.	Purity.
	Number.	*Per cent.*	*Per cent.*		*Number.*	*Per cent.*	*Per cent.*
Arizona	2	7.69	56.9	Nebraska	59	11.44	75.1
Arkansas	2	6.39	58.9	Nevada	18	13.87	82.4
California	9	11.06	76.0	New Hampshire	1	11.62	80.0
Colorado	46	13.61	77.6	New Mexico	16	13.42	75.8
Connecticut	5	11.20	78.9	New York	4	11.05	74.3
Georgia	2	11.02	64.9	North Dakota	11	12.34	73.8
Idaho	1	12.73	74.9	Ohio	61	11.97	78.9
Illinois	36	11.15	75.0	Oklahoma Terr'y	1	6.37	53.0
Indiana	71	11.90	77.6	Oregon	33	13.95	84.5
Indian Territory	1	12.40	81.6	Pennsylvania	7	13.02	77.7
Iowa	314	11.39	75.3	South Dakota	202	12.20	74.4
Kansas	36	10.92	71.2	Tennessee	5	9.77	69.2
Kentucky	3	8.26	60.9	Texas	10	10.53	70.1
Maryland	2	7.75	68.5	Virginia	73	11.06	77.2
Michigan	46	12.77	77.9	Washington	11	14.75	84.2
Minnesota	34	11.56	74.7	Wisconsin	433	11.41	75.9
Missouri	11	10.93	73.5	Wyoming	15	13.04	78.0
Montana	40	13.14	72.5	New Jersey	1	7.33	70.8

NOTE.—It is necessary to give a number of precautions to the reader in order that he may not misapprehend the data given in the preceding table of analyses of beet samples.

In the first place it must be remembered that these beets were all sent by mail or express to the Department, and, with the exception of those localities which were near at hand, several days necessarily elapsed from the time of harvesting the beets until they were received for analysis. Careful experimental data show that beets which are harvested and exposed, even when wrapped for shipment by mail, lose water very rapidly, and therefore the quantity of sugar which the beet contains on analysis is greater really than it possesses in the normal state. It is probable, therefore, that the data given for the content of sugar will average at least 10 per cent too high. Again, it is not fair to compare States which furnished only a few samples, for instance, like Idaho, Arkansas, Arizona, Maryland, Kentucky, etc., with those States which furnished several hundred samples, like Iowa, South Dakota, and Wisconsin. The data must be taken simply to represent the character of the samples sent, and can not be reasonably construed to indicate the suitableness of the soil and climate of any particular State for the production of sugar beets. It must, however, be allowed that in those States, such as Oregon, Washington, and Montana, where the results are exceptionally high, the data show a peculiar suitability to the production of beets rich in sugar.

The State of Washington, with eleven samples, shows the best results of all, producing beets which had an average of 14.75 per cent of sugar, with a purity of 84.2. Next to Washington comes Oregon with 33 samples, showing 13.95 per cent of sugar and 84.5 purity. Other States showing excellent results are—

	Per cent.
Nevada	13.87
Colorado	13.61
New Mexico	13.42
Wyoming	13.04
Michigan	12.77
South Dakota	12.20
Indiana	11.90
Minnesota	11.56
Nebraska	11.44
Wisconsin	11.41
Iowa	11.39

One notable result is that in the arid regions where irrigation is practiced the beets produced are almost uniformly of a high character. The fine results obtained in Washington and Oregon are also most encouraging, inasmuch as in many States, especially on the Pacific coast, the winters are much milder than can be expected in Minnesota, Iowa, Nebraska, and the two Dakotas.

In a general way it is fair to say that with our present knowledge of the subject the culture of the sugar beet, for sugar-making purposes, is more likely to succeed in arid regions where irrigation is practiced and where the winters are mild, and on the Pacific coast, where the beets can be grown without irrigation and where the winters are also mild. This is not said in any way to discourage the introduction of the culture of the beet into other localities which show beets of fair quality but which are subject to winters of greater severity. As has already been indicated, the early advent of killing frost and freezing weather is a matter of serious consequence to beet-growers, interfering, as it does, with the proper harvesting and preservation of the beets.

Great difficulty is experienced in securing common methods of culture and harvesting the samples of beets. There are many cases in which the yield per acre of beet roots reported is absurdly high, reaching, in one case, 99 tons per acre. Any yield exceeding 25 tons per acre which is reported is looked upon with suspicion, and it is probable that the experimenter has made some mistake in determining the yield. While it is not impossible to grow 25 tons of sugar beets to the acre, yet it is very improbable that such a yield should be obtained if all the conditions necessary to the production of beets are observed.

In general, it may be said that the percentage of sugar which has been obtained in these general experiments is satisfactory. When it is remembered that in a great majority of cases many of the conditions necessary to success were doubtless neglected, and when it is further considered that the samples were subjected to every variety of cultivation and to almost every vicissitude of climate, the results can not but be regarded as satisfactory. It is evident, however, that investigations of this kind are not sufficient to secure the introduction of the beet-sugar industry.

The growth of a very small plat of beets is quite different from the cultivation of a large area, and it is yet very problematical whether the farmers of this country will be willing, as a class, to engage in beet culture as long as other forms of agriculture, less onerous and less expensive, prove remunerative. The culture of the sugar beet is essentially a practice of the highest class of agriculture, and will probably not be very popular until the farming lands of our country are more valuable. When farming lands get to be worth from $200 to $300 per acre, the yield of maize and wheat will probably not be sufficient to pay the rental on land of that price. In such case the farmers will be compelled to look for a crop which, under intensive culture, will bring a larger return. Such a crop is evidently to be found in the sugar beet.

In many cases capital has been found waiting to engage in the manufacture of beet sugar, but the promoters of the factory have found it impossible to secure the coöperation of farmers in sufficient numbers to insure a crop of reasonable magnitude. The purpose, therefore, of building a factory in such a locality was given up under compulsion.

Perhaps more serious difficulties in connection with the beet-sugar industry will be found in climatic conditions.

As has been pointed out before, in both annual and special reports of this Department, the area of our Northern States, especially the North Central States, suitable to the production of sugar beets is very large, and it has also been shown by the cultural experiments mentioned above that beets of fine saccharine strength and of large average tonnage per acre can be grown in these localities. The difficulties, however, of having the beets harvested and well secured before the acces-

sion of cold weather are very great. Especially during the present season, severe cold weather was experienced over many parts of the Northern Central States very early in November. It is reported that many thousands of tons of beets which had been grown for the use of factories in those localities were lost through this freezing temperature. It is quite certain that in all localities in our North Central States, and in all localities exposed to the frosts which are likely to occur from northwestern blizzards, arrangements will have to be made by the farmer to have his beet crop harvested and secured by the 1st of November. It is even to be feared that in some seasons the late October days may not be wholly secure against these sudden incursions of northern blizzards.

Whether or not the facilities afforded by these localities for the growth of beets will be considered a sufficient offset for the difficulties attending these climatic catastrophes, experience alone will show. To the region on the Pacific coast these remarks about climate do not apply. The winters of California, Oregon, and Washington are milder than those which prevail in the beet-growing regions of Europe, and it would be only fair to expect the most rapid increase in beet-sugar factories in those localities. Long experience has shown that beets will grow on the Pacific coast with fair tonnage and fair content of sugar, and the winters by their mildness afford exceptional opportunities for manufacture. It must not be supposed, however, that the severity of the winter must be considered an insuperable difficulty in the establishment of a beet-sugar industry. While the cost of siloing the beets may be a little greater, it will not be sufficiently great to wholly destroy the profit of the industry. Full details respecting the beets grown from the seed distributed by the Department will be found in Bulletin No. 33.

SYSTEMS OF TAXATION AND BOUNTY.

Many inquiries are received by the Department in regard to the fiscal system of European nations in respect of sugar beets. In order to supply the required information on this subject, the following digest of the laws of European countries manufacturing beet sugar is given. This digest contains the substance of the law now in force, or about to come into force, in those countries. Appended to this digest is the United States law relating to the bounty on sugar, concerning which numerous inquiries have been directed to this Department; also the law of Canada.

GERMANY.

The law which is at present in force in Germany in regard to the taxation of beet sugar, and the payment of bounties and rebates on exported sugar, went into effect on the 1st of August, 1888, and will expire by limitation of the Reichstag on the 1st of August, 1892.

By the terms of this law beets entering into manufacture are taxed 80 pfennigs ($0.1904)* per 100 kilograms (220.5 pounds)†. This is a reduction of 90 pfennigs from the old law. One of the great innovations of the new law was the imposition of a tax on all sugar entering into consumption in the German Empire of 12 marks ($2.856)‡ per 100

* The value of 1 pfennig is about a quarter of a cent, United States currency.
† The value of 1 kilogram is 2.2046 pounds avoirdupois.
‡ The value of 1 mark is 23.8 cents, United States currency.

kilograms. The rebates on exported sugar under the present law are as follows:

(1) For raw sugar polarizing at least 90 per cent, and for refined sugar containing less than 98 per cent, but at least 90 per cent of sugar, 8.50 marks.
(2) For candies and sugars in white hard loaves, etc., or crushed in the presence of revenue officers, and for all sugars of at least 99.5 purity, 10.65 marks.
(3) For all other hard sugar not containing over 1 per cent of water, and containing at least 98 per cent of sugar, 10 marks.

The amounts stated are for 100 kilograms.

It is thought that the present bounty or profit accruing to the manufacturers amounts to about 2.12 marks per 100 kilograms. The amount of tax collected in Germany for the campaign of 1889–'90 was as follows:

	Marks.		Dollars.
Tax on raw beets	78,600,315	=	18,706,874.970
Amount paid in bounties	65,900,745	=	15,684,377.310
Cost of collection, etc	3,144,011	=	748,274.618
Net receipts for the tax on beets	9,555,557	=	2,274,222.566
Net receipts from tax on sugar entering into consumption	50,814,291	=	12,093,804.258
Making total net receipts of the German treasury from the beet tax	60,369,848	=	14,368,023.824

The following are the chief provisions of the new law in the German Empire, which was passed on the 31st of May, 1891, to go into effect on the 1st of August, 1892: (1) Tax on sugar entering into consumption, 18 marks per 100 kilograms; (2) the duty on imported sugar is fixed at 36 marks per 100 kilograms.

The rebates on exported sugar are paid on three classes of sugar, viz: A. Raw sugar polarizing at least 90° and under 98°; B. Candied, loaf, and other sugars polarizing at least 99.5°; C. Hard sugar containing not more than 1 per cent of water, crystals, lumps, etc., polarizing at least 98°.

The amount of drawback on each of these classes is fixed as follows:

From the 1st of August, 1892, to the 31st July, 1895:

A .... 1.25 marks per 100 kilograms.
B .... 2.00 marks per 100 kilograms.
C .... 1.65 marks per 100 kilograms.

From the 1st of August, 1895, to the 31st July, 1897:

A .... 1.00 marks per 100 kilograms.
B .... 1.75 marks per 100 kilograms.
C .... 1.40 marks per 100 kilograms.

The provisions of the rebate last for only five years, as will be seen, and this is called the transition period, after which it is supposed that no rebate in the form of a premium will be paid.

In case sugar which has been deposited in public warehouses has received the premium mentioned above, and is subseqently withdrawn for consumption at home, the premium which has been paid must be refunded to the treasury. A full description of the law is found in "Zeitschrift des Vereins für die Rübenzucker-Industrie," August, 1891, p. 571 *et seq.*

FRANCE.

In France a new law in regard to the taxing of sugar was promulgated in the Journal Officiel of the 30th of June. The law went into effect on the 1st of September, 1891. It reads as follows:

ARTICLE 1. Commencing from the 1st September next, and for the following campaigns, the legal yield per 100 kilograms of beets worked in the home sugar factories is fixed at 7.750 kilograms.

Where the actual yield of any factory does not exceed 10.5 kilograms of refined sugar per 100 kilograms of beets, the whole of the

excess is admitted to the benefit of the reduced duty enacted by the first paragraph of article 1 of the law of August 5, 1890. The half only of any excess obtained above 10.5 kilograms of sugar per 100 kilograms of beets is subject to this reduced duty, duty being levied on the other half at the full rate of 60 francs per 100 kilograms.

Those manufacturers who, previous to the 1st of November of each year, shall make declaration at the Bureau de la Régie, that they renounce any claim to the benefit of the premium on the excess over legal yield shall be allowed a drawback of 15 per 100 on the total amount of their manufacture. Sugars on which this drawback is allowed are subject to a duty equal to that applicable to the sugars representing the excess yields.

The *prise-en-charge* (legal yield) fixed by the first paragraph of the present article applies definitely under one or the other of the two modes of levying duty above defined, whatever may be the eventual excess of deficit.

ART. 2. The drawback on manufacture allowed to manufacturers who are also distillers by article 6 of the law of August 5, 1890, is reduced to 15 per cent, commencing from the campaign of 1891–'92.

ART. 3. Molasses delivered from one factory to another or to a *sucraterie* under fiscal supervision is credited to the manufacturing account at the rate of 30 kilograms of refined sugar per 100 kilograms of molasses. It is taken into account at the factory where delivered for the quantity of refined sugar with which the account of the sender has been credited. Only molasses already worked and containing not more than 50 per cent 100 of absolute sugar is subject to these conditions.

ART. 4. No modification with regard to the fixing of the legal yield or the drawback, which may be the object of further legislation, shall be applicable before the expiration of one year from the promulgation of the new law.

Temporary provision.

ART. 5. For the campaign of 1890–'91 a drawback of 15 per 100 on the total quantity manufactured shall be allowed to those sugar manufacturers who, by declaration made at the Bureau de la Régie within five days at the latest from the promulgation of the present law, shall renounce any claim to the benefit of the premium on sugar obtained above the legal yield.

The last paragraph but one of article 1, cited above, is applicable to the sugars representing this drawback.

The tax on imported sugar in France is 60 francs* per 100 kilograms. As will be seen, the manufacturer pays at the rate of 30 francs for all sugar in excess of the legal yield of 7.75 kilograms up to 10.5 kilograms. On all sugar over this he pays the full tax of 60 francs per 100 kilograms on one-half of the excess above 10.5 and 30 francs per 100 kilograms on the other half.

The following computation may be made of premiums received by the French manufacturers of sugar when they export it under the present law:

If the beets yield 11 per cent of sugar, the premium amounts to 8.85 francs per 100 kilograms. If the yield be ten per cent, the premium amounts to 8.25 francs per 100 kilograms. If the yield be 9 per cent, the premium will amount to 5.70 francs per 100 kilograms. It is also seen that by one of the conditions of the law all manufacturers are guarantied certain premiums if they renounce any claim to the excess over the legal yield. They will then receive a fixed premium of 4.50 francs per 100 kilograms, being 15 per cent of 30 francs duty which is to be paid. It should also be stated that there is an extra tax of 7 francs per 100 kilograms on all beet sugar imported into France. This tax is not collected on cane sugar imported. In short, according to

*The value of 1 franc is 19 cents, United States currency.

the new law, it appears that the French Government will guaranty to manufacturers of sugar a minimum premium of 4.50 francs per 100 kilograms of sugar. For those manufacturers who work with rich beets, the premium will vary from 8 to 9 francs per 100 kilograms, according to the richness of the beets.

AUSTRIA-HUNGARY.

In Austria the duties on imported sugar, payable in gold, are as follows: On white sugar, 50 francs per 100 kilograms; on raw sugar below 19, Dutch standard, 37.50 francs per 100 kilograms; on sirups, glucose, and molasses, 15 francs per 100 kilograms; there is a duty on indigenous sugar entering consumption of 23.65 francs per 100 kilograms.

When sugar is exported, the following direct premiums are paid:

	Francs.
Per 100 kilograms of sugar polarizing from 88 to 93	3.22
Per 100 kilograms of sugar polarizing from 93 to 99.5	3.44
Per 100 kilograms of sugar polarizing from 99.5 to 100	4.94

The annual maximum of premiums is not to exceed 5,000,000 florins,* or 10,750,000 francs. If the premiums on exported sugar exceed this sum, the excess is to be reimbursed by the sugar factories in proportion to their production. A bond is given by the factories to secure this reimbursement. This bond is 11,000 florins or 23,650 francs ($4,564.450) for each sugar factory.

RUSSIA.

In Russia the new sugar law which has just gone into effect contains the following provisions. The duty on imported sugar is as follows:

For refined sugar	97.68 francs per 100 kilograms.
For brown sugar	73.26 francs per 100 kilograms.

The minister of finance has authority to lower this duty to 36.63 francs per 100 kilograms if the price of sugar reaches 6 ($3.528) to 6.5 ($3.822) rubles† per pood‡ (36.068 pounds) at St. Petersburg, or 5 to 5.5 rubles per pood at Kieff.

The excise duty for sugar in consumption amounts to 17.27 francs per 100 kilograms. Beginning with the campaign of 1892–'93, a supplementary duty will be imposed on refined sugar of 40 kopecks§ ($0.235) per pood, equivalent to 6.83 francs per 100 kilograms; so the total tax for sugar entering consumption from that time will be 24.10 francs per 100 kilograms of refined sugar. The excess of the import tax over the tax on consumption will then be as follows:

For raw sugar	73.26—17.27=55.99 francs per 100 kilograms.
For refined sugar	97.63—24.10=73.58 francs per 100 kilograms.

Admitting that the Government will reduce the duty on imported sugar to the minimum of 1.50 rubles in gold per pood, there will still remain for the manufacturer of sugar in Russia an assured premium, on exportation, of 19.36 francs per 100 kilograms for raw sugar, and 12.53 francs per 100 kilograms for refined sugar. At the present

*The value of the Austrian florin in francs as given above is 2.15. The ratio in gold coin as fixed by the United States Treasury is 1.88 francs.

†The value of 1 ruble is about 77 cents, United States currency.

‡The value of 1 pood is 36 English pounds avoirdupois.

§The value of 1 kopeck is about 0.60 cents, United States currency.

import duty, however, the premiums are greater than that mentioned above.

HOLLAND AND BELGIUM.

In Holland as well as in Belgium the tax upon raw sugar is fixed upon the volume and density of the juice. The legal yield is fixed at 1.46 kilograms of refined sugar or 1.65 kilograms of brown sugar per hectoliter of juice for each degree of density. The tax amounts to 27 florins, equivalent to 56.43 francs, per 100 kilograms of refined sugar. The duty on imported sugar in Holland is as follows:

Candied sugar of the first class, 31.86 florins, equivalent to 66.59 francs, per 100 kilograms.

Candied sugar of the second class, 28.89 florins, equal to 60.38 francs, per 100 kilograms.

White sugar polarizing above 99°, 27 florins, equal to 56.43 francs, per 100 kilograms.

Raw sugars, for each degree of polarization, .27 florins, equal to .56 francs, per 100 kilograms.

The minimum amount of money which the treasury is to receive from sugar is fixed by law for the campaigns of 1892–'93 and 1893–'94 at 8,500,000 florins ($3,417,000). Any deficit in this amount is to be made up by the sugar manufacturers.

SWEDEN.

The duty on indigenous sugar entering consumption is one-half of the duty on imported sugar from May 22, 1891, for sugars below No. 19, Dutch standard. The duty is collected on the weight of beets entering the factory, assuming that the yield in raw sugar is 6.25 per cent on the weight of beets worked.

The rate of duty on imported sugar below No. 18 is 23.5 kronen, equal to 33 francs, per 100 kilograms.

The tax on home-grown raw sugar is therefore 11.75 kronen, equal to 16.5 francs, per 100 kilograms.

DENMARK.

The duty on imported sugar is fixed at the following rates from October, 1891: White sugar above No. 18, Dutch standard, 6 oere* per livre;* white sugar above 9, Dutch standard, 3 oere per livre; white sugar darker than above, 2 oere per livre; molasses and sirup, 1 oere per livre; indigenous sugar is taxed for consumption at the rate of 2.25 oere per livre for sugar above No. 19.

If, however, the total quantity of sugar made does not exceed 32,000,000 kilograms (70,547,200 pounds), then the manufacturers are not required to make good the deficit. The amount of deficiency which each manufacturer is compelled to pay shall in no case ever exceed 6 florins per 100 kilograms of the excess of sugar over the minimum fixed above.

The amount which each manufacturer is compelled to pay is fixed by the minister of finance, and is to be paid within a month after its publication in the *Journal Officiel.*

ITALY.

From November 21, 1891, the duties on sugars imported into Italy are as follows: Sugar of first class, per 100 kilograms, 92 francs; sugar of second class, per 100 kilograms, 76.75 francs. Sugars of first class include all above 20, Dutch standard, or polarizing above 98 degrees.

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* 1 livre = 200 grams; 100 oere = 1.40 francs.

The excise tax on sugar of domestic production is as follows: For sugars of first class, per 100 kilograms, 63.15 francs; for sugars of second class, per 100 kilograms, 55.95 francs.

Indigenous sugar is fostered, therefore, by a protective duty equal to the difference between the tariff on imported sugars and the excise tax on indigenous sugars. This amounts in sugars of the first class to 28.85 francs per 100 kilograms, and in sugars of the second class to 20.80 francs per 100 kilograms.

CANADA.

The governor in council may authorize the payment, out of the consolidated revenue fund of Canada, under such regulations and restrictions as are made by order in council, to the producers of any raw beet sugar produced in Canada wholly from beets grown therein, between the 1st day of July, 1891, and the 1st day of July, 1893, of a bounty of \$1 per 100 pounds, and, in addition thereto, 3½ cents per 100 pounds for each degree or fraction of a degree over 70 degrees shown by the polariscopic test.

UNITED STATES LAWS IN REGARD TO SUGAR.

[Act of October 1, 1890, 26 Stat., 567.]

Bounty on sugar.

On and after July first, eighteen hundred and ninety-one, and until July first, nineteen hundred and five, there shall be paid from any moneys in the Treasury not otherwise appropriated, under the provisions of section three thousand six hundred and eighty-nine of the Revised Statutes, to the producer of sugar testing not less than ninety degrees by the polariscope, from beets, sorghum, or sugar cane grown within the United States, or from maple sap produced within the United States, a bounty of two cents per pound; and upon such sugar testing less than ninety degrees by the polariscope, and not less than eighty degrees, a bounty of one and three-fourths cents per pound, under such rules and regulations as the Commissioner of Internal Revenue, with the approval of the Secretary of the Treasury, shall prescribe.

Notices, applications for license, and bonds.

The producer of said sugar to be entitled to said bounty shall have first filed prior to July first of each year with the Commissioner of Internal Revenue a notice of the place of production, with a general description of the machinery and methods to be employed by him, with an estimate of the amount of sugar proposed to be produced in the current or next ensuing year, including the number of maple trees to be tapped, and an application for a license to so produce, to be accompanied by a bond in a penalty, and with sureties to be approved by the Commissioner of Internal Revenue, conditioned that he will faithfully observe all rules and regulations that shall be prescribed for such manufacture and production of sugar.

Licenses.

The Commissioner of Internal Revenue, upon receiving the application and bond hereinbefore provided for, shall issue to the applicant a license to produce sugar from sorghum, beets, or sugar cane grown within the United States, or from maple sap produced within the United States, at the place and with the machinery and by the methods described in the application; but said license shall not extend beyond one year from the date thereof.

No bounty shall be paid to any person engaged in refining sugars which have been imported into the United States, or produced in the United States upon which the bounty herein provided for has already been paid or applied for, nor to any person unless he shall have first been licensed as herein provided, and only upon sugar produced by such person from sorghum, beets, or sugar cane grown within the United States, or from maple sap produced within the United States. The Com-

missioner of Internal Revenue, with the approval of the Secretary of the Treasury, shall from time to time make all needful rules and regulations for the manufacture of sugar from sorghum, beets, or sugar cane grown within the United States, or from maple sap produced within the United States, and shall, under the direction of the Secretary of the Treasury, exercise supervision and inspection of the manufacture thereof.

Payment of bounties—No bounty upon less than five hundred pounds.

And for the payment of these bounties the Secretary of the Treasury is authorized to draw warrants on the Treasurer of the United States for such sums as shall be necessary, which sums shall be certified to him by the Commissioner of Internal Revenue, by whom the bounties shall be disbursed, and no bounty shall be allowed or paid to any person licensed as aforesaid in any one year upon any quantity of sugar less than five hundred pounds.

Penalties.

That any person who shall knowingly refine or aid in the refining of sugar imported into the United States, or upon which the bounty herein provided for has already been paid or applied for, at the place described in the license issued by the Commissioner of Internal Revenue, and any person not entitled to the bounty herein provided for, who shall apply for or receive the same, shall be guilty of a misdemeanor, and upon conviction thereof shall pay a fine not exceeding five thousand dollars, or be imprisoned for a period not exceeding five years, or both, in the discretion of the court.

Import duties—Beet-sugar machinery free until July 1, 1892.

All sugars above number sixteen Dutch standard in color shall pay a duty of five-tenths of one cent per pound: *Provided,* That all such sugars above number sixteen Dutch standard in color shall pay one-tenth of one cent per pound in addition to the rate herein provided for, when exported from, or the product of, any country when and so long as such country pays or shall hereafter pay, directly or indirectly, a bounty on the exportation of any sugar that may be included in this grade which is greater than is paid on raw sugars of a lower saccharine strength; and the Secretary of the Treasury shall prescribe suitable rules and regulations to carry this provision into effect: *And provided further,* That all machinery purchased abroad and erected in a beet-sugar factory and used in the production of raw sugar in the United States from beets produced therein shall be admitted duty free until the first day of July, eighteen hundred and ninety-two: *Provided,* That any duty collected on any of the above-described machinery purchased abroad and imported into the United States for the uses above indicated since January first, eighteen hundred and ninety, shall be refunded.

Sugar candy and all confectionery, including chocolate confectionery, made wholly or in part of sugar, valued at twelve cents or less per pound, and on sugars after being refined, when tinctured, colored, or in any way adulterated, five cents per pound.

All other confectionery, including chocolate confectionery, not especially provided for in this act, fifty per centum ad valorem.

Glucose, or grape sugar, three-fourths of one cent per pound.

Provisions take effect April 1, 1891.

That the provisions of this act providing terms for the admission of imported sugars and molasses, and for the payment of a bounty on sugars of domestic production, shall take effect on the first day of April, eighteen hundred and ninety-one: *Provided,* That on and after the first day of March, eighteen hundred and ninety-one, and prior to the first day of April, eighteen hundred and ninety-one, sugars not exceeding the number sixteen Dutch standard in color may be refined in bond without payment of duty, and such refined sugars may be transported in bond and stored in bonded warehouse at such points of destination as are provided in existing laws relating to the immediate transportation of dutiable goods in bond, under such rules and regulations as shall be prescribed by the Secretary of the Treasury.

Free list.

Sugars, all not above number sixteen Dutch standard color, all tank bottoms, all sugar drainings and sugar sweepings, sirups of cane juice, melada, concentrated melada, and concrete and concentrated molasses, and molasses.

Conditional duty on sugar.

That with a view to secure reciprocal trade with countries producing the following articles, and for this purpose, on and after the first day of January, eighteen hundred and ninety-two, whenever, and so often as the President shall be satisfied that the Government of any country producing and exporting sugars, molasses, coffee, tea, and hides, raw and uncured, or any of such articles, imposes duties or other exactions upon the agricultural or other products of the United States, which in view of the free introduction of such sugar, molasses, coffee, tea, and hides into the United States he may deem to be reciprocally unequal and unreasonable, he shall have the power, and it shall be his duty, to suspend, by proclamation to that effect, the provisions of this act relating to the free introduction of such sugar, molasses, coffee, tea, and hides, the production of such country, for such time as he shall deem just, and in such case and during such suspension, duties shall be levied, collected, and paid upon sugar, molasses, coffee, tea, and hides, the product of, or exported from, such designated country, as follows, namely:

All sugars not above number thirteen Dutch standard in color shall pay duty on their polariscopic tests as follows, namely:

All sugars not above number thirteen Dutch standard in color, all tank bottoms, sirups of cane juice or of beet juice, melada, concentrated melada, concrete and concentrated molasses, testing by the polariscope not above seventy-five degrees, seven-tenths of one cent per pound; and for every additional degree or fraction of a degree shown by the polariscopic test, two-hundredths of one cent per pound additional.

All sugars above number thirteen Dutch standard in color shall be classified by the Dutch standard of color and pay duty as follows, namely: All sugar above number thirteen and not above number sixteen Dutch standard of color, one and three-eighths cents per pound.

All sugar above number sixteen and not above number twenty Dutch standard of color, one and five-eighths cents per pound.

All sugars above number twenty Dutch standard of color, two cents per pound.

Molasses testing above fifty-six degrees, four cents per gallon.

Sugar drainings and sugar sweepings shall be subject to duty either as molasses or sugar, as the case may be, according to polariscopic test.

Alcohol free of tax for making sugar from sorghum.

[Extract from act approved March 3, 1891, making appropriations for the Department of Agriculture for the fiscal year ending June 30, 1892.]

That any manufacturer of sugar from sorghum may remove from distillery warehouses to factories, used solely for the manufacture of such sugar from sorghum, distilled spirits in bond free of tax, to be used solely in such manufacture of sugar from sorghum; that all distilled spirits removed as herein authorized shall be of an alcoholic strength of not less than one hundred and sixty per centum proof, and may be removed, stored, and used in the manufacture of sugar from sorghum, and when so used may be recovered by redistillation in the sugar factory of such sugar manufacturer under such bonds, rules, and regulations for the protection of the revenue and the accomplishment of the purposes herein expressed as the Commissioner of Internal Revenue, with the approval of the Secretary of the Treasury, may prescribe.

Any person who removes or uses distilled spirits in violation of this provision, or the regulations issued pursuant thereof, shall, on conviction thereof, be fined not less than one thousand dollars nor more than five thousand dollars for each offense, and the spirits and the premises on which such spirits are used shall be forfeited to the United States.

THE MUCK LANDS OF THE FLORIDA PENINSULA.

The establishment by this Department of an experimental station at Runnymede, Fla., for investigating the growth of sugar cane in reclaimed swamp muck has rendered some account of that kind of soil important.

The possibilities of bringing into successful cultivation the swamp lands of Florida have occupied the minds of capitalists for several years. It has now been about ten years since Mr. Hamilton Disston, of Philadelphia, formed the plan of reclaiming the swamp lands of Florida for agricultural purposes by drainage canals. These lands are found in detached localities over the whole State, but the parts of them which demand our attention at the present time are found extending from near the central portion of the peninsula in a southerly direction to Lake Okeechobee, and thence into the Everglades to the Gulf. It is

on these lands that the experiments of reclamation have been made, and several thousand acres of swamp lands have been already freed of water and made ready for cultivation. Of these lands, at the present time, about 2,000 acres are planted in sugar cane, from 5,000 to 6,000 acres in rice, and quite a large area in gardens.

Vast tracts of reclaimed land, however, are still in the wild state, the water simply having been taken off them, but no attempts having been made to fit them for cultivation.

The muck lands, which form the subject of the present paper, begin near the head waters of the St. Johns, about 20 miles southeast of the town of Orlando. These lands form the borders of the lakes and rivers, but the chief deposits are about the lakes. The configuration of the internal lakes of Florida is of the simplest nature. About the edges of the lakes the waves have thrown up a ridge of sand and muck, and this ridge is usually covered with cypress trees. Back of these come the swamp lands proper, which, during the greater part of the year, before the system of drainage was established, were under water. These swamp lands vary in width from a very few feet to many miles, and are bordered in turn by the sand and pine lands.

The first of these lakes in geographical order is known as Lake Hart. A canal has been cut from this lake to the head waters of the St. Johns, and a large area of rich vegetable mold has been recovered. All other systems of drainage in the lands to which reference is made are drained toward the south, Lake Hart marking the watershed between the head waters of the St. Johns and the head waters of the Kissimmee. Only a few miles south of Lake Hart is found Lake East Tohopekaliga. This lake has been drained by a canal into Lake Tohopekaliga, on the shores of which is found the town of Kissimmee. Lake Tohopekaliga has also been connected by a drainage canal with Lake Cypress, and Lake Cypress by another drainage canal with Lake Kissimmee. Lying east of Lake East Tohopekaliga is found another series of lakes, viz, Lake Preston, the most northern one, Lake Alligator, central, and Lake Gentry, the most southern of the three. These lakes are soon to be connected by drainage canals, and the last one, Lake Gentry, is to be opened into Lake Cypress. About sixty sections of land, or, in all, about 40,000 acres of rich muck land will be recovered as soon as these canals are finished.

Passing from Lake Kissimmee into the Kissimmee River, we find a stream bordered on both sides by rich deposits of muck passing gradually into the sand and pine lands back of them. The river is extremely tortuous, and while the distance from Lake Kissimmee to Lake Okeechobee is only about 60 miles in a direct line, a boat, following the course of the river, passes over nearly 150 miles in order to reach the lake.

No attempts have been made so far to reclaim the muck lands bordering the Kissimmee River by canals, and it is not possible to accomplish this by natural drainage. The level of the Kissimmee River, even at low water, is almost the same as that of the muck lands bordering it, and, during the rainy season, lasting from June till October, the river becomes a veritable lake. There would, therefore, be no possibility of natural drainage for these lands, but by the construction of levees along the river and the introduction of pumps, many thousands of acres could be recovered. Artificial drainage is no longer an experiment, but in many parts of the country it is practiced with entire success. The plantations on the Mississippi River below New Orleans are nearly all provided with artificial drainage systems, inasmuch as the natural drainage in that locality is entirely insufficient to free the lands

from water. The great fertility of the Florida muck soils would render such a system of drainage profitable as soon as the country is opened up to the markets of the North.

Passing from the Kissimmee River through Lake Okeechobee, we come to the largest body of muck lands in the world. The northern shores of Lake Okeechobee are fringed with a very little muck, but as you approach the southern border the muck deposits become deep and wide until finally they merge into those vast deposits of muck which form the northern border of the Everglades. The exact extent southward of this body of muck is not known, but it has been accurately surveyed for a distance of about 50 miles, and found to be of excellent character throughout the whole of this distance.

As has been said before, the problem of drainage for the muck lands for the central portion of the peninsula, beginning with Lake Hart and continuing to Lake Cypress, is an exceedingly simple one. All that is necessary to secure the drainage is the construction of canals. This is easily done by dredge boats, inasmuch as the muck is easily moved and a good dredge boat is able to cut 300 feet of muck a day, 8 feet deep and 50 feet wide. When, however, we come to the vast deposits of muck on the Okeechobee, the problem is quite a different one. Two methods of procedure have been proposed. One of these contemplates nothing else than the drainage of Lake Okeechobee itself. This body of water is a peculiar one. It receives through its principal tributaries and the Kissimmee River most of the drainage of the central peninsula of Florida. It has, however, no outlet except the overflow through the Everglades into the Gulf and westerly through the marshes into the head waters of the Caloosahatchee. The building of a canal to the Atlantic Ocean, which would remove the surplus water of the Okeechobee and permanently lower its level, would be an undertaking of considerable magnitude. The nearest distance is about 40 miles directly eastward from the central eastern part of the lake. The whole of this distance, however, would be through sand which, of course, is much more difficult to move, on account of its greater compactness and greater weight than the muck itself; it is therefore probable that it would be more economical to cut the canal in a southerly direction from the center of the southern border of the lake directly through the muck into the Everglades. A careful computation of the amount of drainage received by Lake Okeechobee would show that for the purpose of securing open drainage during the rainy season, the canal would have to be 300 feet wide and 12 feet deep. Such a canal would permanently lower the water 6 feet in the lake and would make ready for cultivation the vast body of muck lands already described.

The second method proposed is one which is now actually in operation, viz, the drainage of a portion of the muck lands of the Okeechobee. The system which is proposed, and which is now largely completed, looks to the recovery of only a portion of the land on the southwestern border of the lake. Lake Hicpochee is a small body of water, which, at its nearest point, is distant only about 6 miles from Lake Okeechobee. A canal has been constructed from Lake Okeechobee to Lake Hicpochee. A longer canal, about 18 miles, has also been built almost directly east from Lake Hicpochee to connect with Lake Okeechobee at another point. Westerly from Lake Hicpochee a canal has already been built into Lake Bonne and Lake Flirt connecting them with the head waters of the Caloosahatchee.

The next step in this scheme for the reclamation of this body of land consists in the erection of a levee along the borders of the lake. This

levee is to extend to the pine lands at two points, one about 15 miles north of Lake Hicpochee and another at some point south of it, at such convenient distance as may be found necessary for the work. The levee along the bank of the Okeechobee will completely protect this portion of the land from any overflow from this lake. The drainage through the system of canals established to the head waters of the Caloosahatchee will be sufficient to carry off the natural rainfall of this body of land. About 50,000 acres of land are included already in the canals which are under construction, and a very little additional expense would increase this area to 100,000.

Col. J. M. Kreamer, at my request, has made an approximate estimate of the total amount of muck lands indicated in the scheme already given. He estimates the amount at 1,000,000 acres. He says:

> These lands are found in bodies of greater or less extent throughout the Kissimmee valley, the northern limit being in the vicinity of Lake Hart. A map of the region west of Lake Okeechobee shows, in detail, the extent and depth of saw grass or muck soil, and the ease with which it can be reclaimed and cultivated by labor-saving appliances was fully discussed by us during your recent trip through the Okeechobee country. This tract is now (July 22, 1891,) virtually dry, due to the low stage of water in Okeechobee and vicinity. The surface of the soil is at least 30 inches above the water level. Reports from Okeechobee show that the muck lands south of the lake are all at present above the water level from 18 inches to 2 feet. We are cutting a canal to the southwest from a point on the shore of Lake Okeechobee near Ritta River.

By the single canal connecting Lake Okeechobee with Lake Hicpochee and thence to the Caloosahatchee, the level of the water in the Okeechobee has been permanently lowered from a foot to 18 inches. If one small canal, through the imperfect drainage system of the Caloosahatchee River, can secure this result, we can easily imagine the success which would attend the construction of the large canal mentioned above.

The total elevation of the highest point of this muck land system, viz, Lake Hart, above the tide level is about 72 feet. Lake Okeechobee itself is 20 feet above the tide. It is thus seen that there is abundant natural fall to carry off the whole of the water provided a canal of sufficient size can be constructed.

The origin of the muck soil is, of course, vegetable matter. There are no data for estimating the length of time required for the formation of these muck deposits. It is known that it must have been of great duration. For this reason it is not probable that the flora which is found over the muck region at the present time would represent accurately the character of the vegetation in prehistoric times. I have had samples collected of the principal vegetable growths which cover the muck lands at the present time. The whole of the Okeechobee muck lands is covered almost exclusively by saw-grass. This is a cyperaceous plant of the genus *Cladium;* its botanical name is *Cladium Mariscus* or *C. effusum*. During the winter and early spring months this dense growth of grass often becomes dry enough to burn, and large areas are often burned over. Other plants which are, at present, contributing to the growth of muck, are as follows:

Common name.	Botanical name.
Yellow pond lily	Nymphea flava.
Maiden cane grass	Panicum Curtisii.
Alligator wampee	Pontederia cordata var.
Sedge	Cyperus sp.
Fern brake	Osmunda sp.
Mallow	Malva sp.
Broom sedge	Andropogon sp.
Arrow weed	Sagittaria.

In regard to the depth of the soil, it varies from the merest covering at the edges near the sand to from 15 to 16 feet in its deepest portions. The greater part of the muck lands, as before indicated, will vary from 3 to 6 feet in depth, while along the Okeechobee the average depth is much greater. The soil varies in color from almost jet black to black brown.

The subsoil lying under the muck in the upper region around Kissimmee is pure sand. The Okeechobee muck, however, is underlaid with a thick stratum of shell marl containing pebbles very rich in phosphorus, and this rests upon a coralline or limestone formation. This limestone formation is very porous in structure, full of cavities of varying sizes, capable of being ground with extreme ease and thus prepared for application to the soil. At distances which vary from 2 or 3 miles to perhaps 15 or 20 from the shore of the lake this limestone formation comes nearest to the surface and forms a kind of a natural dam for the waters of the lake. This line of demarcation may properly be considered as the border between the Lower and Upper Everglades.

Of course every plan of constructing a canal through the muck lands must include the breaking up of this crust when it approaches the surface. This, however, is most easily done and would oppose no great barrier to the progress of the work. This crust has already been broken through by the drainage company in opening the Upper Caloosahatchee to a freer connection with Lake Okeechobee, through Lakes Flirt and Boone, by the system of canals already described.

As will be seen further on, the muck soils of Florida are markedly deficient in mineral constituents. The presence, therefore, of so large a body of limestone, mingled with phosphatic pebbles, is a matter of no mean importance when the agricultural future of these lands is considered. A few of these pebbles were picked up at the headwaters of the Caloosahatchee and examined for phosphoric acid. The mean percentage of phosphoric acid found was 0.697. This region has not been prospected at all for phosphate deposits, but it would not be surprising if they were discovered to exist here in great abundance, as they are found from 60 to 100 miles farther west, in the Peace River region.

The question of the subsidence of these soils under cultivation is also one of considerable importance. If the organic matter which they contain should decay there would, of course, be a marked depression in the level of the soil. The oldest portions of the muck land in cultivation have now been tilled for about eight years. In these lands, where sugar cane was planted it has been found that there has been a subsidence of several inches, so that the stubble of the sugar cane has been left protruding to this distance above the surface. This depression, however, seems to have occurred chiefly in the first two or three years of the cultivation, and there seems to have been no such marked lowering in the surface of the soil since that time. It is not likely, therefore, that the soil will ever again be sufficiently depressed to bring it under the level of the water, although it must be confessed that the period of observation has been entirely too short to make any definite prophecy in regard to the future.

The organic matter, however, of the muck lands does not seem to be subject to complete decomposition by the natural processes of decay. The humic bodies, consisting largely of carbon, appear to be capable of resisting partially, if not altogether, the oxidation to which they are exposed by cultivation. There is considerable danger, however, from fire, especially during the dry season. When fires are once started with dry muck they continue to burn until the lands are flooded on the

accession of the rainy season. But even in cases where a complete burning of the soils by conflagrations of this kind is observed the depression does not appear to be very great, and these places are entirely above the water line, except, perhaps, in times of very severe rains. There is, therefore, it is thought, no danger in the future of such a depression of the land as to render unavailing the drainage which has been accomplished.

The question of climate is also one of prime importance, especially in consideration of the culture of sugar and rice.

In regard to precipitation, the climate of Florida is divided distinctly into a rainy and a dry season. The rainy season begins early in the summer, in the latter part of May or June, and continues until about the middle of September or the 1st of October. From October to June the climate of the central peninsula of Florida is essentially dry, although showers may frequently occur. This distribution of the rainfall has its advantages and disadvantages. So far as the culture of rice is concerned, it is extremely advantageous. The rainy season occurs during the time when the rice fields are to be flooded, and thus the necessity for artificial flooding is greatly diminished by the great rainfall of the summer. There is also an advantage to the growing cane crop in having the rainfall come during the hot months, at the period of most rapid growth. It is equally as advantageous, however, during the manufacturing period, to have a dry season. For this reason the period of the manufacture of sugar in Florida has many advantages over the same time of the year in Louisiana. In Louisiana, especially after November, the planter is exposed to frequent and protracted rains, rendering the fields muddy, and the roads over which the cane is to be hauled almost impassable. The Florida planter can confidently count on a continuous manufacturing season, being rarely interrupted by rains. The disadvantages of the dry season in the central peninsula of Florida are chiefly felt by the growers of vegetables. These vegetables are grown for the early northern markets, and the gardening period in central Florida begins about the last of December, and ends about the first of May. It is during this season that rains are most infrequent, and therefore the gardener is subjected to grave dangers from drought. It is during the same period, too, that the spring planting of sugar cane takes place, and, owing to the dry weather, the planted cane may be affected with dry rot. The disadvantages, however, of the dry season are easily overcome by artificial irrigation, which, on account of the level surface of the soil and the short distance which the water must be pumped, is rendered particularly easy. By establishing a pump near a branch of the lake and raising the water about 8 feet, the whole of the muck lands can be easily irrigated. It is not necessary that the water be brought to the surface of the soil at all, as, on account of the porous nature of the muck, the land is thoroughly moistened by subirrigation; it is only necessary to bring the water high enough to allow it to flow into the drainage ditch to secure a complete permeation of the soil with moisture. Upon the whole, therefore, in regard to precipitation, it may be said that the climate of the central peninsula of Florida is favorable, not only to the growth of the staples—sugar and rice—but also for market gardening.

In regard to the temperature, equally favorable conditions obtain. Frosts are of rare occurrence, and when they do occur usually do but little injury. Only twice in eight years have the eyes of the cane been injured by frost, and even in these cases they were not all killed. In no instance has cane been known to freeze in the Florida peninsula,

during the period over which these observations extend. It may be said, therefore, that no danger need be apprehended by the planter, even in the central portion of the peninsula, from frost. On account of this immunity from frost, the cane may be allowed to ripen during the months of November and December, and grinding operations need not begin until January or even later. The climatic conditions of temperature, therefore, in this respect, approach those of the island of Cuba. This being true of the central portion of the peninsula, it is true in a much greater degree of the lower portion, viz, the Okeechobee section. In this region frosts are almost entirely unknown. The cocoanut and the date palm flourish, and tropical plants of every description predominate over the subtropical. In March, 1891, during a visit to this region, numerous fields of cane were seen along the Caloosahatchee which had not yet been cut, and which, although not entirely green, were only affected in color by the maturity of the plant presenting a rich yellowish green. In this region the sugar cane is absolutely free from any danger from frost, although occasionally light frosts have been known to injure more delicate plants. It may be said, then, with confidence that in the region of the Okeechobee Lake the lands which may be recovered for sugar-making purposes have all the advantages of the climate of Cuba.

The manufacture of sugar from the cane in this region may be postponed with perfect safety until the beginning of February, and the months of February, March, and April be the months of greatest activity in sugar manufacture.

On account of the ease of irrigation, the whole area of the muck lands of Florida is particularly well suited to the growth of rice. In regard to the actual success of rice culture, however, it is not possible to speak from any but theoretical considerations, inasmuch as until the present year no experiments of any consequence have been made in rice culture. During the present season several thousand acres have been planted in rice on the muck and semimuck lands of the State, and the result of this trial will be awaited with interest by those interested in the agriculture of that region.

In regard to the culture of rice, it may be said that it can be grown on the muck lands of slight depth, known as prairie lands. These lands often have a covering of only a few inches of muck, underneath of which is found firm, hard, white sand. These lands are not suitable to the culture of cane, but are supposed to be well suited to the growth of rice.

Another important consideration in connection with the muck lands of the Okeechobee country is found in the method contemplated for their cultivation. These lands will be intersected by numerous drainage canals, and by means of these canals not only can the land be cultivated by steam from engines carried on boats in the canals themselves, but also the products of the fields can be transported on the same canal, with an economy which will render the competition of mule or horse power methods of cultivation almost impossible. Competent engineers have made estimates for the actual cost of steam cultivation, on the canal system indicated above, and, allowing for all contingencies of unexpected expenses, it appears reasonable to say that, with the yield of cane which can be secured on such lands, it will be possible to place the cane at the doors of the factories, by means of a system of canals used in irrigation and cultivation, at an expense which will fall below $2 per ton. This expense includes all the cost of cultivation, harvesting, and transportation.

It is not necessary to dwell upon the fact that with cane produced at such a cost, even the island of Cuba could not compete with Florida in the production of sugar. There is practically no other body of land in the world which presents such remarkable possibilities of development as the muck lands bordering the southern shores of Lake Okeechobee. With a depth of soil averaging, perhaps, 8 feet, and an extent of nearly half a million acres, with a surface almost absolutely level, it affords promise of development which reaches beyond the limits of prophecy.

THE CONSTITUTION OF THE MUCK SOILS.

Preliminary examinations of the muck lands of Florida have been made by Mr. D. C. Sutton, of the Department of Agriculture, assistant in charge of the experiment station at Runnymede. Three samples of the soil were taken by him, of which No. 1 was from the oldest cultivated land on the estate of the Florida Sugar Manufacturing Company's station, about 4 miles from the experimental field at Runnymede. Soil No. 2 was from a portion of the field which had been in cultivation for only a short time. No. 3 was taken from a spot further back, on the lands of the same company near the prairies. The results of the analyses are given in the following table:

	No. 1.	No. 2.	No. 3.
Insoluble matter	23.21	21.45	40.80
Soluble silica	.02	.02	.08
Potash	.11	.10	.07
Soda	.17	.15	.10
Lime	.16	.16	.10
Magnesia	.01	.01	.007
Peroxide of iron, alumina	3.06	2.79	1.83
Phosphoric acid	.19	.16	.09
Sulphuric acid	.01	.01	.01
Organic matter	68.11	70.52	53.65
Carbonic acid, chlorine, and loss	4.95	4.63	3.263
	100.00	100.00	100.00

These analyses were made before the establishment of the experiment station at Runnymede. On the establishment of this station it was deemed advisable to make a more complete analysis of the soils from the station itself. For this purpose, four samples of soil were taken, two of them from the station and two from old cultivated land, in order to determine the degree of change which would take place during cultivation. The two samples which were taken from the station are shown.

Sample No. 1 was taken from the front part of the station, near the cypress grove. Sample No. 2 was taken from the back part of the station land, near the pine land. These two samples show the two distinctive characters of the muck. The first sample is a muck of a brown color which drains easily and is very porous. No. 2 is a muck of a deep black color, more compact, and less easily drained. Sample No. 3 was taken from the orchard of the St. Cloud plantation, about 4 miles from the station, from a portion of land which, at present, is planted in grapes and has been in cultivation for five years, principally in vegetables. Sample No. 4 was taken from a field on the St. Cloud plantation which has been in cultivation in cane for five years.

In samples 1 and 2 is shown a complete section of the soil from the top and the sand below. Samples 3 and 4 were purposely taken from

the surface in order to show the effect of cultivation and oxidation on the character of the soil.

FLORIDA SOILS.

[Dried at 110°.]

	Carbon.	Hydrogen.	Volatile.	Absorption.	Nitrogen.
Soil No. 1.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
8976, first foot	57.67	4.48	90.60	145.14	2.24
8977, second foot	47.07	5.15	72.00	108.50	1.40
8978, third foot	8.52	0.53	15.00	46.68	0.31
Soil No. 2.					
8979, first foot	56.21	6.08	91.70	151.15	2.33
8980, second foot	58.57	6.04	96.50	188.32	2.83
8981, third foot	48.27	6.34	96.76	156.98	2.33
8982, fourth foot	21.72	2.03	40.88	81.05	0.95
Soil No. 3.					
8983	18.72	2.72	45.60	114.03	1.26
Soil No. 4.					
8984	19.48	2.69	45.70	167.95	1.18

The above figures show the composition of the soil in layers of 1 foot. Sample No. 1 had a depth of 3 feet, but the last foot was largely mixed with sand, as is shown by the decrease in carbon, hydrogen, nitrogen, and absorptive power, and the increase in mineral or nonvolatile matter.

Under the column "absorption" is given the percentage of water which the perfectly dry soils will absorb. It is seen that the pure muck, where unmixed with sand, will absorb more than its own weight of water, in one case almost double its weight. The importance of this property in times of drought and in relation to subirrigation must not be overlooked. The quantity of nitrogen in the layer of muck immediately above the sand is much less than in other parts of the soil, but this is not due to any impoverishment of the muck itself, but to the great admixture of sand. In the dry muck which has not been cultivated the value of the nitrogen reaches in one case $10.19 per ton, estimating nitrogen at 18 cents a pound. Cultivation for a few years reduces the percentage of nitrogen in the surface soils, as is indicated by the numbers obtained with samples 3 and 4.

NATURAL PHOSPHATE DEPOSITS.

The number of inquiries received by the Department of Agriculture, and submitted to the Division of Chemistry for answer, on the question of natural phosphates, has been greater than in any preceding year. The number of these inquiries will doubtless continue to increase, unless some information can be transmitted to those intending to send them in regard to the data which are on record in this office concerning these deposits.

No examination of natural phosphate deposits has been made by the Division of Chemistry nor by any division of the Department. Inquiries in regard to the extent and nature of phosphatic deposits should be sent to the Director of the Geological Survey, Bureau of Mineral Statistics.

In regard to the extent and character of the Florida phosphate deposits there may be cited a work by Francis Wyatt, entitled "The

Phosphates of America," published by the Scientific Publishing Company of New York.

For general information in regard to the Florida deposits, it may be said that they extend from Taylor and Madison counties, in the northern part of the State, southward and southeastward beyond Citrus County, forming a strip from 120 to 150 miles in length, with an average width of about 20 miles. It must be stated, however, that the exact extent of these deposits has not yet been determined; new deposits are discovered continually, and old ones are found to be of larger extent than supposed.

In regard to pebble phosphates, which were supposed to exist only in the Peace River, they have now been found in the Caloosahatchee, and dredging for these pebbles is already in progress above the town of Fort Myers. This would seem to indicate that the head waters of the Caloosahatchee also pass through phosphate deposits, and they have not yet been explored.

According to Prof. E. T. Cox, the beds of phosphate are not continuous, but are interrupted by protruding masses of underlying Eocene rocks. The Florida phosphates exist in two forms: first, what is called the rock phosphate, which exists in beds or layers and is mined like ordinary stone; and second, pebble phosphate, consisting of pebbles or phosphatic materials which have been disintegrated by the action of water and are found lying in the beds of streams. This stratum of pebble formation, where it has been cut by the streams, is said to be from 3 to 30 feet in thickness. In some localities the pebbles form fully 50 per cent of the whole mass, and the soft clay matrix in which they are embedded contains a high percentage of phosphoric acid. The composition of the best qualities of Florida phosphate is indicated by the following analyses of typical samples. In these samples Nos. 8879, 8881, and 8882 are samples of rock phosphate and number 8880 pebble phosphate:

Sample No. 8879.

Probable form of occurrence:	Per cent.	Estimated as—	Per cent.
Calcium fluoride	3.06	Calcium oxide	49.93
Calcium carbonate	8.45	Ferric oxide	0.60
Tricalcium phosphate	79.36	Aluminic oxide	2.03
Magnesium phosphate	0.59	Magnesium oxide	0.27
Aluminum phosphate	1.67	Phosphoric anhydride	37.65
Aluminum silicate	3.70	Water at 100°	0.24
Silica	0.38	Silica	2.74
Ferric oxide	0.60	Fluorine	1.49
Water at 100°	0.24	Carbonic dioxide	3.72
Organic matter and fixed water	2.17	Organic matter and fixed water	2.17
	100.22		100.84
		Less oxygen equivalent to fluorine	.63
			100.21

Sample No. 8880.

Probable form of combination:	Per cent.	Estimated as—	Per cent.
Calcium carbonate	14.59	Calcium oxide	52.42
Tricalcium phosphate	83.50	Ferric oxide	0.40
Magnesium phosphate	0.33	Aluminic oxide	0.67
Magnesium oxide	0.42	Magnesium oxide	0.57
Aluminic oxide	0.67	Phosphoric anhydride	38.42
Ferric oxide	0.40	Water at 100°	0.34
Water at 100°	0.34	Carbonic dioxide	6.44
	100.25		100.27

Sample No. 8881.

Probable form of combination:	Per cent.	Estimated as—	Per cent.
Calcium fluoride	1.48	Calcium oxide	49.86
Calcium carbonate	18.71	Ferric oxide	1.19
Tricalcium phosphate	71.86	Aluminic oxide	2.11
Magnesium phosphate	0.60	Magnesium oxide	0.28
Aluminum phosphate	4.66	Silica	0.49
Aluminic oxide	0.16	Phosphoric anhydride	35.67
Silica	0.49	Fluorine	0.72
Ferric oxide	1.19	Water at 100°	0.99
Water at 100°	0.99	Carbonic dioxide	8.23
Organic matter and fixed water	0.77	Organic matter and fixed water	0.77
	100.31		100.31
Less oxygen equivalent to fluorine	.16	Less oxygen for fluorine	.16
	100.15		100.15

Sample No. 8882.

(Partial analysis.)

Estimated as—	Per cent.		Per cent.
Calcium oxide	41.65	Phosphoric anhydride	30.18
Ferric oxide	1.60	Water at 100°	0.37
Aluminic oxide	3.38	Loss on ignition	8.60
Magnesium oxide	0.38		

In connection with Florida phosphates, an interesting question has arisen concerning the method of applying them as fertilizers. Florida phosphates are more easily disintegrated, softer, and apparently in better condition to be assimilated by plants than almost any other natural phosphate known. This physical condition has led to experiments looking to the use of such phosphates as fertilizers without previous treatment with sulphuric acid. As is well known, most mineral phosphates are first treated with sulphuric acid in order to set the phosphoric acid free before being used for fertilizing purposes. On the other hand, the phosphate of lime which exists in bone, as is well known, is readily assimilated by plants without any previous treatment. The same is true of the phosphoric acid existing in the basic slags, a waste product in the manufacture of steel by the basic process.

Florida phosphates have been used, during the present year, to a considerable extent, directly applied to the soil without previous treatment with sulphuric acid, and the results are said to be favorable. It will be understood, however, that a single year's trial would not be sufficient to determine this fact. The matter, however, is of sufficient importance to deserve further investigation. If it should prove true that these phosphates are equally valuable without previous treatment with sulphuric acid, it will enable them to be delivered to the farmers at a much less price per ton than superphosphates could possibly be furnished. The whole of the expense of the sulphuric acid needed in the treatment, and the cost of the treatment, would be saved. During the coming year, experiments will be inaugurated on the sugar experiment station at Runnymede, Fla., with this purpose in view.

It may be well to say that this property, if it should prove to be a property, of Florida phosphates seems to be in opposition to the general views of agriculturists and chemists concerning the use of phosphates. With the exception of the cases noticed, which will be further discussed below, it

is the general opinion of scientific agriculturists that mineral phosphates at least require to be previously treated with sulphuric acid in order to produce any beneficial effect upon the crop. This is true, at least of any immediate beneficial effect, since it is recognized that sooner or later even the most refractory phosphates would be decomposed under the combined influence of meteorological causes and plant growth, and the phosphoric acid which they contain be rendered assimilable. If, therefore, the plant could have plenty of time, there is no doubt of the fact that it would gradually consume the phosphatic ration which was fed to it. This, however, is not what agriculturists want. While they are perfectly willing to fertilize a field for its value in the future, they do not want their reward postponed too long. The farmer wants a result the very first year of the application of the fertilizer and, therefore, at the present time, his mineral phosphate must be previously treated with sulphuric acid. If the Florida phosphates should prove an exception to this rule, it would be a great benefit to agriculture and would permit the free use of many phosphates now rejected by manufacturers of superphosphates on account of their high content of iron and alumina.

USE OF BASIC SLAG AS A FERTILIZER.

In the manufacture of steel by the basic process, so called, the ore from which the steel is made is treated in the furnace with an excess of lime, by means of which the phosphoric acid which it contains is almost entirely separated, and passes into combination with the lime as a tetracalcium phosphate. Ordinary mineral phosphates and the phosphate in bones, on the other hand, have a chemical composition known as tricalcium phosphate. The phosphates of the basic slag, therefore, have one more atom of lime to the molecule than the ordinary mineral phosphates and bone phosphates.

For several years, experiments have been carried on which have finally demonstrated beyond any reasonable doubt that the phosphoric acid in basic slags is available for plant food without previous treatment with sulphuric acid for the formation of superphosphates, as is done with natural phosphates. It will be seen by noticing the analyses which follow that the treatment of basic slags with sulphuric acid would be a very expensive one. Not only would the sulphuric acid be compelled to unite with the lime, which is already in union with the phosphoric acid, but in addition to this, large quantities of it would be consumed in combining with the lime, in a free state in these slags, and with a large amount of iron which they contain. This would not only cause a great expense in the use of sulphuric acid, but would also convert the iron into the form of green vitriol or ferrous sulphate, in which condition it might prove injurious to some plants when applied in large quantities; although when applied in the usual proportions of fertilizers it probably would have no injurious effect.

The slags coming from the furnaces are of two kinds; one being simply a mass of slag material without definite crystalline form, and the second having a definite crystalline structure. The chemical composition of the two forms varies chiefly in the fact that the crystalline slags are particularly free from excess of lime and iron, although the phosphate of lime which they contain exists in the same form as it does in the slags in general.

Two forms of crystalline slags have been examined in the Division of Chemistry during the present year, one containing acicular crystals and

the other tabular crystals. The composition of these two forms of crystals will be seen from the following table of analysis:

	Acicular crystals.	Tabular crystals.
	Per cent.	*Per cent.*
Calcium oxide	42.69	53.61
Ferric oxide	20.98	9.64
Aluminic oxide	3.71	.91
Magnesia	.49	.08
Vanadium dioxide	.18	....
Phosphoric anhydride	27.06	33.92
Silica	4.96	1.75
Total	100.07	99.91

The study of the crystals of the tetrabasic calcium phosphate is not new in chemical literature. Several years ago artificial crystals were prepared and analyzed. Observations on the grouping of the crystals in the slag tend to show that the first crystals to appear are the tabular ones. After these come the brown hexagonal needles, and the deeply colored, lustrous forms appear to come last of all.

The appearance of vanadium, a very rare element, in the slags would go to show that it is present in the ores from which they are made. Although vanadium is a rare and valuable element, its occurrence in this small quantity would probably not prove of any commercial value. The chief use of vanadium is in the application of its salts in dyeing. It helps to form very fast colors with certain forms of dyes.

Within a year or two the industry of furnishing basic slag as commercial fertilizers in this country has assumed large proportions. For many years the steel works in this country have been dumping their slags, under the impression that they were valueless. On account of their being easily pulverized, and from the fact that the phosphoric acid which they contain is so readily assimilable, they have, however, obtained a considerable value within a year or two.

These slags, when properly prepared, are now sold on the market for from $15 to $17 per ton, containing from 20 per cent to 25 per cent of phosphoric acid. It must not be forgotten that these slags probably act in a beneficial way apart from their mere content of phosphoric acid. The lime which they contain appears to be in excellent condition for producing a proper flocculation of the soils. The application, therefore, of basic slag to stiff, clayey soils would doubtless prove highly beneficial aside from their content of phosphoric acid. Thus, in the application of this fertilizer, we find a double benefit; first, the improvement which it makes in the physical condition of the soil, and second the amount of plant food available in it.

Before leaving this subject, it is deemed appropriate, in view of its importance and of the widespread interest existing in regard to it as shown by the numerous inquiries received at this office asking for information on the subject, and in view, also, of the lack of definite information regarding the character and value of these phosphate lands to which reference has been made, to earnestly recommend that this division be empowered to thoroughly investigate the subject, with special reference to the availability and value of these phosphate deposits to the agricultural interests of the country. Information has been received that large investments in these phosphate lands have been made by European, principally British, capitalists, and, as the time will certainly come when agriculture will be more dependent in this country upon artificial

fertilizers than at present, it would seem eminently desirable that this Department should be in a position to impart definite information to our people in regard to our own resources in the way of available fertilizing material.

A PROMISING BUTTER ADULTERANT.

Mr. H. J. Fish, superintendent of the Producers' Dairy Company, 324 B street SW., Washington, D. C., brought to me a sample of genuine butter, together with a sample of artificial butter, prepared by taking equal parts, by weight, of the genuine butter and milk and churning them together with the addition of a small quantity of the substance known as "gilt-edge butter compound," from the Planet Manufacturing Company, of Wichita, Kans. The directions for the use of this compound are to take a pint of fresh unskimmed milk and as much of the compound as you can heap on a silver 10-cent piece, and thoroughly mix the compound and milk together in the churn with as much salt as is necessary to salt 1 pound of butter. Add to this 1 pound of soft butter, and churn until the whole mass has come to butter, when you will have 2 pounds of butter and no milk. It is directed that the genuine butter should not be melted but made very soft and pliable so that the churn dasher will easily go through it. The milk should be warmed to the temperature at which it is taken from the cow. The churn should always be scalded or warmed sufficiently to prevent chilling the milk, plenty of salt added, and butter color, if used, before churning. It is particularly enjoined that the butter should not be worked, but should be made into rolls and put into jars and set away in a cool place to harden.

The sample of genuine dairy butter which was furnished with the compound was found to contain—

	Per cent.
Water	15.92
Butter fat	80.53
Ash	0.38
Curd and undetermined	3.17

This represents a fair sample of butter, with the exception that the water is a little higher than the average. In the premium butters obtained at the Chicago Dairy Show in 1889, the percentage of moisture varied in ten samples from 8.69 per cent to 11.86 per cent.

The artificial butter prepared from the above by the Producers' Dairy Company was subjected to analysis, and the following numbers were obtained:

	Per cent.
Water	49.55
Butter fat	45.45
Ash	1.34
Curd and undetermined	3.66

There was no doubt at all that the gilt-edge butter compound would do what was claimed for it, inasmuch as Mr. Fish had made the butter himself according to the directions.

The compound was also submitted to a practical test in the laboratory of this Department, and it was found that with 1 pound of butter, 1 pint of milk, and about 1 gram of the butter compound, 2 pounds of material could easily be made which resembled very closely a first-class article of butter, except that it was considerably softer.

It was at once suspected that the compound contained some emulsifying substance, either of a mineral nature or some organic ferment.

On subjecting the butter compound to analysis it was found to contain 70.48 per cent of anhydrous sodium sulphate and 29.52 per cent of organic matter. This organic matter responded perfectly to the test for pepsin, and it is undoubtedly pepsin; whether a pure pepsin or a crude form was not determined. Having established the fact that this is pepsin, experiments were made with pepsin and other digestive ferments, viz, pancreatin and trypsin. These bodies act as pepsin, and produce an emulsion which enables butter to incorporate an equal weight of milk in its substance without materially altering its appearance. The experiments were also tried with rennet, and it was found to act in the same way; whence it may be concluded that all the digestive ferments, when beaten up with milk and butter in the manner indicated, will produce an emulsion apparently causing the milk to entirely disappear.

The gilt-edge butter compound is colored pink, with some organic coloring matter in order to obscure its real nature. The anhydrous sodium sulphate seems to be added simply as a carrying material, and it is not supposed to produce any active effect in the emulsifying process; in fact, pepsin, pancreatin, trypsin, and rennet used without anhydrous sodium sulphate produce exactly the same emulsifying effect as the gilt-edge butter compound.

By this simple device the unprincipled dealer could easily impose upon his customers, furnishing them with an article of butter containing only half of the portion of that substance without greatly diminishing its price. The keeping properties, of course, of the emulsified butter would not be so great, but for rapid home consumption this would not be noticed.

MEAT PRESERVATIVES.

To determine the extent to which preservatives are added to canned meats an investigation has been carried on with certain meat preparations with the following results:

The preservatives which have been used in canned meats are: (1) Salt; (2) nitrate of potash; (3) sulphurous acid; (4) boric acid; (5) benzoic acid; (6) salicylic acid; (7) saccharin; (8) hydronaphthol. Fluosilicates are said to be used on rare occasions, but owing to the small chance of their presence, they are not included in the scheme.

The number of bodies used for this purpose has been gradually increasing with the demand, and with this increase in numbers comes a great increase in the difficulties of detecting and separating them. The search for preservative agents will soon come to be one of the most important operations in the examination of canned and preserved goods of all sorts.

SALT.

Salt seems to be the body generally used for the preservation of the so-called concentrated foods; such preparations as Liebig's extract of beef, Armour's beef extract, and many others containing 20 per cent of it, and sometimes even more. Ordinary potted meats contain it to the extent of from 1 per cent to 4 per cent. Salt is best detected in the ash. It has been the custom in making this determination to char the meat, extract with water, burn residual carbon to ash, add aqueous extract and evaporate. Salt is easily detected in the soluble ash, either by adding silver nitrate or by examining for cubical crystals which should deposit as the solution evaporates.

Potassium nitrate (niter, saltpeter) is used principally in the preservation of fresh meat. Meat is generally painted with a strong solution of it and then subjected to transportation.

Nitric acid may be tested for in several ways: (1) By making a Kjeldahl nitrogen determination, using the modification for nitrates; (2) by treating the meat with water (in the case of preparations containing much fat, preferably after extraction with ether) and testing the solution so obtained for nitric acid by one of the usual methods. It may also be detected by the formation of picric acid, as follows:

Phenol sulphonic acid is prepared by dissolving 1 part of phenol in 5 or 6 parts of strong sulphuric acid and diluting with an equal volume of water. The solution containing nitric acid is evaporated to dryness in a porcelain or platinum dish, and 1 or 2 cubic centimeters of the phenol sulphonic acid added; it is warmed gently, cooled, water added, followed by an excess of ammonia, when the well-known yellow color of ammonium picrate will make its appearance should nitric acid be present.

This salt (*i. e.*, nitrate of potash), in doses of from 1 to 2 ounces per diem, acts as a sedative on the circulation; in much larger doses it acts as a poison.

SULPHUROUS ACID.

When used as a preservative, sulphurous acid generally occurs in combination with calcium, sodium, or ammonium, in the form of sulphites or bisulphites. It is used in connection with some other preservatives to form many of the mixtures now on the market under fancy titles. Its use as a preservative has been prohibited in many countries.

The only reliable test for sulphurous acid in foods seems to be distillation in a current of carbon dioxide, and the collection of the acid in the distillate by appropriate means. Oxidation to sulphuric acid by means of iodine is used for this purpose with final precipitation as barium sulphate.

The gas is received in a solution of iodine in potassium iodide, acidulated with hydrochloric acid, and contained in a flask or beaker. Heat is applied to the flask and the distillation continued for half an hour. If sulphurous acid is present, it will be oxidized to sulphuric acid by the iodine, and may be precipitated by barium chloride as barium sulphate.

Dr. Forster reports a case of poisoning by "meat preserve," calcium sulphite, in SO_2.

BORIC ACID.

It is used principally in the form of its sodium salt, borax ($Na_2B_4O_7$). The most reliable information about the physiological action of boric acid seems to point to its comparatively harmless character, though authorities differ widely on this point. However, in spite of this, most countries have prohibited its use as a food preservative. Endemann says boric acid is a preservative of fresh meat only. The following passage regarding its preservative properties is taken from Thorpe's Dictionary:

E. le Cyon states that meat preserved by borax is not diminished in nourishing properties and that it is more readily assimilated, whereas Le Bon asserts that meat so preserved is useless as a food. T. Forster concludes that the use of boric acid in preserving food is of questionable value, as it increases the secretion of bile and the excretion of albuminous matters. Gruber likewise states that the decomposition of albumen in animals is increased by borax. Vigier, on the contrary, concludes from a series of experiments on dogs and men, that borax has no injurious effects even in large doses.

The four preceding preservatives are sometimes added singly to foods, but there are many mixtures of two or more of them on the market

under fancy titles. The following mixtures have been analyzed by E. Polenske: Ammonium sulphite; sulphurous acid; soda; borax crystallized; boric acid; salt; sodium sulphate; sodium sulphite; potassium nitrate; sulphite of lime; water.

Fresh meat is painted or injected with these. Some contain a trace of an aniline red dye, added, perhaps, to resemble blood.

BENZOIC ACID.

The most delicate test yet published for benzoic acid is that proposed by Mohler. Quantities of less than one-half a milligram may be easily detected by it in the absence of interfering bodies. It depends upon the formation of ammonium-meta-di-amido benzoate of a peculiar reddish brown color. The residue from an ether extraction is treated with 2 or 3 cubic centimeters of strong sulphuric acid and heated until fumes of the acid appear. Organic matter is charred and benzoic acid changed into sulpho-benzoic acid. A few crystals of potassium nitrate are added; the carbonaceous matter is first oxidized, and afterwards meta-dinitro benzoic acid formed. When cool, the acid is poured into water and ammonia added in excess, followed by a drop or two of ammonium sulphide, which causes the reduction to ammonium-meta-diamido benzoate, after first having passed through ammonium nitro-amido benzoate. Benzoic acid must be first separated in a state of approximate purity before this test can be made. Fats extracted from a beef tongue with ether (the tongue being known to be free from antiseptics) treated as above gave a color reaction which closely resembled that given by benzoic acid. This reaction is given by saccharin, hydronaphthol, β-naphthol, but not salicylic acid.

Benzoic acid is said to possess antiseptic properties greatly superior to salicylic acid, and, moreover, unlike salicylic acid, it is quite as active in the form of a salt. It is added to foods also because the methods for its detection are not so delicate and simple as in the case of salicylic acid. Benzoic acid acts as an irritant to the alimentary mucous membrane.

C. Ruche has found a very delicate test for albuminoids by the use of benzoic aldehyde. The test is applied as follows:

> The albuminoid, either solid or in solution, is treated with a considerable quantity of strong hydrochloric acid, a few drops of ferric chloride added, followed by a few drops of a dilute alcholic solution of benzoic aldehyde. In a short time an intense blue color is developed. The reaction is prompted by heat. By using a bit of the white of a hard-boiled egg, as the source of albumen, it is possible to detect so small a quantity as two or three tenths of a milligram of benzoic aldehyde. In this case the edges of the piece of egg are tinged blue.

An endeavor has been made to apply this test to the detection of benzoic acid after first effecting its reduction to benzoic aldehyde, but no one has been able to perform the reduction satisfactorily. Salicylic aldehyde gives the same reaction, though it does not seem to be so sensitive.

SALICYLIC ACID (ORTHO-HYDROXY-BENZOIC ACID).

When an aqueous solution of salicylic acid is treated with ferric chloride a beautiful purple color results. This reaction is very delicate, and plainly indicates the presence of 1 part of salicylic acid in 100,000 parts of water. The color is destroyed by alkalis and acids. It is not, however, peculiar to salicylic acid. It is a reaction common to many members of the phenol group, and is given by phenol, the cresotic acids,

resorcinol, salicylic aldehyde, and some others. However, this reaction is more delicate in the case of salicylic acid, and there is little chance, for the present, at least, of any of these bodies being added to food stuffs.

Its isomers, meta and para hydroxy benzoic acids, are without antiseptic properties. Griffiths describes its use as a cure for phthisis:

> When given in doses just sufficient to manifest its presence, symptoms closely resembling those of cinchonism result. These are fullness of the head, with roaring and buzzing in the ears. After larger doses, to these symptoms are added distress in the head or positive headache, disturbances of hearing and vision (deafness, amblyopia, partial blindness) and excessive sweating.

Salicylic acid in the form of its sodium salt is a popular remedy for rheumatism. It has to be given with care, however, on account of its strong action on the heart. There are actually cases of poisoning by it on record.

It is used largely to preserve articles of food and is especially popular for beer and wines. Its use as a preservative has been prohibited in most countries.

SACCHARIN (BENZOYL SULPHURIC IMIDE).

Saccharin is a white powder, slightly volatile at 100° and melting at 200° C. It does not distill over with steam. Soluble in 1,000 parts of cold water and 100 parts hot. Its most characteristic property is its intensely sweet taste, which is variously stated as being from 130 to 300 times sweeter than cane sugar, and is perceptible in 10,000 parts of water. It forms salts in which the hydrogen atom of the imide group is replaced by metals. It is said to be uninjurious, and when taken internally passes unchanged through the system into the urine. It is largely used as a substitute for sugar in diabetes and as a preservative for such substances as its sweet taste will permit.

According to Salkowski, commercial saccharin is liable to contain ortho-sulpho-benzoic acid and para-sulphamido-benzoic acid.

When a solution of saccharin in caustic potash is evaporated and the residue heated to 250° C., salicylic acid is formed, and may be tested for with ferric chloride after neutralization. This test is quite delicate, but has the disadvantage of being inapplicable in the presence of salycylic acid.

When saccharin is heated with a few drops of strong sulphuric acid and a slight excess of resorcinol, the mixture becomes first yellow, then red, and finally dark green, with the evolution of fumes of sulphur dioxide, and a body closely resembling fluorescein is formed. The heating should be repeated two or three times. Then, after cooling, water is added, followed by an alkali in excess, which gives a red solution exhibiting a strong green fluorescence. It is claimed for this test that it will detect one part of saccharin in several million parts of solution. Unfortunately, the test is not characteristic of saccharin, for both salicylic and benzoic acids give equally fluorescent solutions. In the case of benzoic acid it is possible that the body formed is benzylfluoresceine.

Advantage may be taken of the fact that saccharin contains sulphur. By heating it with sodium hydrate and nitrate, extracting with water, and aciduating, sulphuric acid may be thrown down with barium chloride. Little definite is known about its physiological properties.

Its use as a food preservative has been prohibited in France, Germany, and Belgium.

HYDRONAPHTHOL.

The composition of this body seems to be doubtful. It is stated by Griffiths that "hydronaphthol is the di-hydroxy-naphthalene of the chemist;" at least this is the case with the article manufactured by Messrs. Seabury & Johnson, London. It is also stated by Beebe that hydronaphthol is but a trade name for β-naphthol. In order to determine at least whether hydronaphthol is a mono or di-hydroxy-naphthaline, a sample of Seabury & Johnson's make was recrystallized from water, carefully dried, and the carbon and hydrogen estimated in it by combustion with copper oxide, with the following results:

	Hydronaphthol.	Theory for—	
		$C_{10}H_7(OH)$.	$C_{10}H_6(OH)_2$.
Carbon	84.74	83.33	75.00
Hydrogen	5.22	5.55	5.00

These results, in connection with the great similarity in crystalline form between β-naphthol and hydronaphthol, would seem to be sufficient to prove that it is β-naphthol. It must be remembered that no special precautions were taken in the preparation of the sample for analysis, and also that while standing awaiting the combustion it had assumed a distinct reddish-brown tinge; otherwise it might have agreed more closely with theory.

It is a white crystalline powder, which partially turns brown on standing, of a faint tarry odor. Its physical properties resemble those of β-naphthol. It is soluble in 2 parts of alcohol, 2 of ether, 300 of hot water, 1,100 of cold, and also readily in alkaline solutions. It is readily volatile with steam, and may also be distilled from its ammoniacal solution and in small quantities from its solution in caustic soda. It is said to be a great germicide, perfectly harmless, and an excellent antiseptic dressing for wounds. β-naphthol has been injected hypodermically without bad effects. It has been introduced into the stomach of a rabbit to the extent of 3.8 grams without producing death; the fatal dose for man would then be about 250 grams. Regarding the physiological properties of hydronaphthol, we have been able to find very little on record.

When hydronaphthol is acted on with strong nitric acid and the resulting nitro compound treated with potassium cyanide and warmed on the water bath, an isopurpurate of a deep red color is formed, resembling exactly that produced when picric acid is treated in the same way. This reaction is given by some other bodies, and is therefore not characteristic.

When hydronaphthol is dissolved in very dilute ammonia, rendered feebly acid with dilute nitric acid, and a drop of a solution of potassium nitrite added, a beautiful rose-red solution is obtained. The solutions must be cold, and the ammonia and acid so dilute that no appreciable amount of heat will be evolved during neutralization, otherwise the delicacy of the test will be greatly impaired. It will detect 1 part of hydronaphthol in 10,000 parts of water. This test is not given by any of the other preservatives.

The popular impression that preservatives are uniformly added to canned meats is doubtless erroneous. In thirty samples which have been carefully examined only two were found which had been treated with preservatives. One of these contained benzoic acid and the other hydronaphthol.

TEA, COFFEE, AND COCOA PREPARATIONS, AND THEIR ADULTERATIONS.

Tea, coffee, and cocoa preparations have received considerable attention in the investigation of foods by the Division of Chemistry. The enormous consumption of the beverages bearing these names is sufficient to tempt the unscrupulous dealers, and consequently the markets are flooded with spurious or adulterated coffees and cocoas, but probably with few teas which in the strict use of the word can be considered adulterated. As will be shown by this report, the practice of adding foreign leaves to the teas sold in this country does not seem to exist and teas are remarkably free from adulteration. Coffees and cocoas, on the contrary, are very frequently adulterated.

TEA—GENERAL CLASSIFICATION.

The substitution of teas of one grade for those of another can be practiced with impunity unless the samples are submitted to an expert. It requires one skilled in such matters to sort and "taste" teas.

METHOD OF MANUFACTURE.

The methods of preparing teas differ in the different countries in which this commodity is grown. In India the manufacturing processes are very simple, black teas only being produced. The method of preparing "black teas" consists essentially in withering the leaves by exposure to the sun or fire ; after withering they are rolled and twisted. The rolled leaves are subjected to a fermentation, after which they are dried—a process termed "firing."

In the manufacture of "green teas" the leaves are steamed or heated over a charcoal fire, then rolled and dried. The same plant furnishes the leaves for either black or green tea, the differences being due solely to the methods of curing.

The following table giving analyses by Kozai, of the Japan Imperial College of Agriculture, indicates the effect of the different methods of curing the leaves of the tea plant. The percentages are referred to the dry matter:

	Original leaves.	Green tea.	Black tea.
Crude protein	37.33	37.43	38.90
Crude fiber	10.44	10.06	10.07
Ethereal extract	6.49	5.52	5.82
Other nitrogen-free extract	27.86	31.43	35.39
Ash	4.97	4.92	4.93
Theine	3.30	3.20	3.30
Tannin	12.91	10.64	4.89
Soluble in hot water	50.97	53.74	47.23
Total nitrogen	5.97	5.89	6.22
Albuminoid nitrogen	4.10	3.94	4.11
Theine nitrogen	0.96	0.93	0.96
Amido nitrogen	0.91	1.13	1.16

According to these analyses there is a diminution in the tannin in both the green and black teas, but especially in the latter. The "other nitrogen-free extract" increased at the expense of the tannin. The theine remains practically constant. This diminution in the tannin is probably one of the reasons why the greatest consumers of tea, the English, consider black more wholesome than green tea.

THE ADULTERATIONS OF TEAS.

The adulterations of tea consist in (1) facing, (2) the addition of spent or partially exhausted leaves, (3) the addition of foreign leaves, and (4) the addition of foreign astringents and substances designed to affect the apparent quality or strength.

The process termed "facing," consisting in treating the leaves with certain pigments for the purpose of improving their appearance, should be considered an adulteration, since this treatment always has a fraudulent intent. These facing agents sometimes, it is claimed, amount to a considerable percentage of the weight of the tea. There is little evidence that the coloring matters employed are poisonous or in any way injurious to health. Spent or partially exhausted leaves are employed as an adulterant. Such leaves are rerolled, dried, and colored before mixing with genuine teas. These leaves are difficult of detection. Foreign leaves are also sometimes employed in the adulteration of teas. The genuine leaves may be distinguished from the foreign by their characteristic structure. A tea that is deficient in strength for any cause, especially through the addition of exhausted leaves, is sometimes treated with an astringent, such as catechu. The object of the catechu is to replace the tannin removed in brewing the tea, or to make up for a natural deficiency in strength.

An adulterated tea may contain gypsum, soapstone, or other mineral matter. These substances are added with the facing materials. Sulphate of iron is said to be sometimes added to teas to deepen the color of the infusion.

This list covers the principal adulterants of teas. Among others which have been mentioned by various writers are metallic iron, sand, particles of brick, etc. Certain green teas are popularly supposed to derive their color from contact with copper plates in drying or curing. There is no analytical evidence to prove that copper in any form has been employed for this purpose. A large number of teas have been examined both in the Division of Chemistry, and in other laboratories, without in a single instance detecting even a trace of copper.

SUMMARY OF THE RESULTS OF AN EXAMINATION OF TEAS BOUGHT ON THE OPEN MARKET.

The sixty-three samples which were examined in the course of these investigations were bought in stores of all grades. The samples represent teas of all prices, from the lowest to the highest. Many of the samples were of very inferior quality, but neither the chemical nor microscopical data give positive evidence of the addition of spent or foreign leaves. The ease with which foreign leaves can be separated from tea leaves precludes the possibility of any such having escaped detection. It is possible, though not probable, that spent leaves may have been added to a few of the teas.

A Canadian official chemist found two teas containing foreign leaves. A more recent report from the same laboratory, upon examination of fifty-eight teas, states that not a single foreign leaf was found.

Dr. Jesse P. Battershall, as reported in his work on food adulteration, examined nearly 2,000 samples of tea, and found foreign leaves present in but few instances. These samples were selected to meet the requirements of the United States tea adulteration act, which compels an inspection of all teas arriving at our ports, and, further, that adulterated teas shall be exported or destroyed. The samples examined were classed as doubtful by the inspectors. The evidence of these analysts, together

with the results of the work of this Department, indicate that our markets are practically free from teas containing foreign leaves.

Many of the teas examined contained frayed leaves; this was not confined to the cheaper grades, but even the highest priced often contained such leaves. There was no positive evidence of the admixture of spent tea, though in some instances the frayed leaves rendered the samples somewhat doubtful.

A large number of samples were heavily faced. Facing should be condemned on account of its use in making inferior teas appear to be of a superior grade. This practice also enables the admixture of spent leaves with little fear of detection. Faced teas can not be excluded from this country under the terms of the United States tea adulteration act.

The analytical and other work in connection with this report indicate that there are few if any spurious teas on the market. The range in quality is undoubtedly great, many samples deserving the name "tea" simply because they have been prepared from the leaves of the *thea*, and not through the many pleasant qualities which we usually associate with the beverage of this name. With the strict enforcement of the United States tea adulteration act the consumer is reasonably well protected so far as securing the genuine leaf is concerned, but of course has no protection from the sale of practically worthless teas.

COFFEE.

Coffees are very frequently adulterated and to a very considerable extent. In the investigations of the Division of Chemistry a large number of coffees have been examined, and certain classes have usually been found to be adulterated.

Genuine coffee is prepared from the seeds of the *Coffea arabica*. Various substitutes have been prepared by manufacturers for the purpose of cheapening the cost of this beverage and defrauding the consumers. In the manufacture of these so-called substitutes, and in the adulteration of genuine coffees, chicory, cereals, and acorns occupy a prominent place. Few of these substances have even little in common with coffee, and possess none of the valuable properties of the latter.

About 60 per cent of the coffee consumed in this country is imported from Brazil. The relative sizes of coffee beans is shown in the following table by Thorpe:

Number of seeds in a measure holding 50 grams of water.

Fine brown Java	187
Fine Mysore	198
Fine Neilherry	203
Costa Rica	203
Good ordinary Guatemala	207
Good La Guayra	210
Good average Santos	213
Fine long-berry Mocha	217
Good ordinary Java	223
Fine Ceylon plantation	225
Good average Rio	236
Medium plantation (Ceylon)	238
Manilla	248
Ordinary Mocha	270
West African	313

As may be seen from this table, Brazil coffees (average Rio) consist of rather small beans. In general, the values of coffees vary inversely as the size of the beans. Mocha is usually considered the best coffee of

commerce. It is stated that East India coffees are sometimes shipped to Arabia, and exported from this latter country as genuine Mocha. The seeds of the Mocha are small and dark yellow.

Java coffee, when new, is a pale yellow, and is then cheaper than when old and brown. This color is partly a result of the method of curing in addition to the effects of age. The high price of Java has led to the coloring of cheaper grades with certain pigments in imitation of this favorite coffee. It may be well to state that this practice can not be general, since no foreign coloring matters were found in the Javas examined in the course of the investigations made in connection with this report, though it is probable that coffees colored by exposure to a high moist heat may have escaped detection.

THE ADULTERATIONS OF COFFEES.

Chicory, leguminous seeds, and cereals are the principal adulterants. Many persons prefer coffee containing an admixture of chicory.

FACING OR COLORING.

Inferior or damaged coffees are frequently treated by some process for the improvement of their appearance and in imitation of superior grades. Java seems to be especially subject to this treatment. South American coffees are often exposed to a high moist heat, which changes their color from green to brown, thus forming imitation Java. The following pigments may be used: Scheele's green, yellow ocher, Silesian blue, chrome yellow, burnt umber, Venetian red, drop black, charcoal, and French black.

CHICORY.

Chicory is prepared from the root of the *Cychorium intybus*. This substance is easily detected by the microscope. Roasted chicory will sink in cold water, leaving a trail of color behind it. Chicory itself is frequently adulterated with other roots or with cereals or leguminous seeds.

CEREALS, LEGUMINOUS SEEDS, AND ACORNS.

Judging from the investigations made, chicory is not as frequently employed as an adulterant as cereals, peas, beans, acorns, etc. These substances are in general detected by the presence of starch, and are finally identified by their structure as shown by the microscope.

MISCELLANEOUS ADULTERANTS OF COFFEES.

The following substances are reported as being sometimes employed in the adulteration of coffees: Canna seed, sawdust, oak bark, and baked liver. They are detected by the microscope.

COFFEE SUBSTITUTES.

A number of substitutes have been proposed for coffee. Many of these have little claim to be entitled substitutes, since they simply furnish a decoction more or less bitter and of a coffee color. Besides chicory, Mogdod coffee (seeds of *Cassia occidentalis*), Mussænda coffee (supposed to be the seeds of *Mussænda borbonica*), acorns, figs, leguminous seeds, burned sweet potatoes, and cereals have been employed as coffee substitutes.

Coffee substitutes should always be sold in packages bearing a dis-

tinctive label, and when mixed with genuine coffee, the percentage of each substance should be stated.

ARTIFICIAL COFFEES.

Within two or three years the coffee markets have been presented with so-called artificial coffees. The first official action toward suppressing this fraud in this country was probably that taken by the health officers of New Jersey.

Reports from dealers in various parts of the country indicate that the sale of artificial coffees has become very general. These "coffees" are usually manufactured in imitation of genuine coffee, and as far as regards color and shape would usually escape detection by the consumer.

The following is a list of the artificial coffees examined, together with a description and statement of their probable composition:

Serial No. 8766. Coffee, bran, and molasses, roasted but not molded.

8767. Bran and molasses, roasted but not molded. Samples, numbers 8766 and 8767, were obtained through the courtesy of Dr. J. N. Hurty, chemist, Indianapolis, Ind.

8491. Imitation coffee beans, roasted. Composed principally of wheat flour.

8859. Imitation coffee beans, roasted. Composition: Wheat flour, coffee, and chicory.

8883. A rather poor imitation of roasted coffee beans. Imported from Germany as "Kunst Kaffee." This sample was obtained from the customs authorities. A number of samples of Kunst Kaffee have been obtained from different sources. Composition: Wheat flour, chicory, pea or bean flour, and probably nut shells. Caffein has been reported in Kunst Kaffee and was supposed to have been derived from Kola nuts. This imitation coffee is wholesaled to mixers at about 11 cents per pound.

8884. Imitation roasted coffee beans. Composition: Wheat flour, coffee, and chicory.

8885. Imitation green coffee. This sample contains two kinds of "berries," one containing wheat flour and and the other wheat flour and coffee. There were no indications of mineral coloring matter.

8951. "Coffee pellets," molded, but not in the form of coffee beans. When mixed with ground and probably with whole coffee these so-called "pellets" would probably escape the notice of the purchaser. Composition: Wheat flour, ground bran, and probably rye. Sold at 5½ or 6 cents per pound in 100-barrel lots.

8952 and 8953. Same composition and manufacture as No. 8951, differing only in color and shape.

8954. Ground artificial coffee. Composition: Chicory, leguminous seeds (peas or beans), wheat, barley, and fragments of buckwheat.

8955. Imitation roasted coffee beans. Composition: Wheat flour.

8956. Two kinds of imitation roasted coffee beans, one consisting of wheat flour and the other of wheat flour and woody tissue, probably sawdust.

8957. Imitation roasted coffee beans. Composition: Wheat flour. Selling price, 11½ cents per pound.

8958. Granular artificial coffee. Composition: Hulls of leguminous seeds, probably peas, formed into granules with molasses, then roasted.

8996. Sample marked "Coffee substitute, Columbia AAA." Composition: Bran and molasses formed into small lumps and roasted.

According to recent information, a factory has been seized in France which manufactured an artificial coffee of the following composition: Chicory, 15 kilograms; flour, 35 kilograms; and sulphate of iron, 500 grams. This, as may be seen, is far from being an innocuous mixture.

The *Kunst Kaffee* (serial No. 8883), imported from Germany, pays a

duty of 2 cents per pound as a coffee substitute. It seems strange that an article whose very form is suggestive of fraud should be admitted under any circumstances at our custom-houses.

Wheat flour and bran mixed with molasses seem to be the favorite materials for the manufacture of imitation coffees. It is hardly to be expected that the manufacturers would select a good quality of flour, but probably they employ damaged or worthless flour, refuse biscuit, and the waste of the bakeries.

The sample numbered 8954 apparently contains mill sweepings, judging from the number of cereals employed.

A large number of ground coffees have also been examined. A large proportion of these samples were grossly adulterated.

There is reason to believe that the retailer is often an innocent party to the fraud. In one instance artificial coffee was found in a sample obtained from one of the most reputable grocers in Washington. A large number of samples were afterwards purchased from this grocer, all of which were free from adulterants of any kind. On investigation the roaster proved to be the guilty party. Pure coffee was delivered to the roaster, and he, after appropriating a portion of this coffee, made up the deficiency with the artificial article, returning a mixture to the dealer.

The limits of this abstract will not permit a more extended review of the adulteration of coffee; suffice it to say, that all coffee preparations, as well as whole and ground coffees, are subject to sophistication. Samples of the so-called "coffee extracts" have been examined which did not contain a particle of genuine coffee. Fortunately the adulterants of coffee can easily be detected.

The practice of adulterating coffees is widespread, and the consumer has little if any protection, not even always the honesty of his grocer, since the latter is also liable to be deceived.

COCOA AND COCOA PREPARATIONS.

The raw material from which the cocoas and chocolates of commerce are manufactured is the "cocoa bean," the seed of the cocoa, or cacao, tree (*Theobroma cacao*). While this tree has been successfully introduced into various warm countries, tropical America, its native land, still furnishes the larger and more highly valued portion of the world's supply of cocoa. The tree is 20 to 40 feet in height, blooms continuously, and yields two crops a year. The seeds are embedded in a fleshy fruit resembling a cucumber; when first removed they are colorless, fleshy, and covered with mucilage; on drying, with exposure to air and light, they become golden yellow to red brown in color and hard and brittle in texture. They are egg-shaped, somewhat compressed, one-half to three-quarters of an inch long and one-quarter of an inch broad.

After removal from the fruit two processes are used for the preparation of the seeds for market. For the preparation of "unfermented cocoa" they are freed from adhering pulp and at once dried in the sun. For the production of "fermented cocoa" the beans are placed in piles in sheds or are buried in trenches and allowed to ferment for a time before being completely dried in the sun. When buried the beans are placed in casks or other coverings; hence the earthy coating is no longer a mark for determining which process has been used. Much of the acridity and bitterness disappears in this process of fermentation. The beans so prepared have a mildly oleaginous, pleasant, slightly bitter taste, are more or less aromatic, and are greatly preferred to the unfermented beans for the manufacture of chocolate, etc. The value of

the product is largely dependent on the care bestowed on this operation. Considerable loss occurs in the subsequent processes of sifting, hand picking, roasting, and removal of husks. The total losses are from 16.76 per cent to 25.78 per cent, with a mean of 22.11 per cent. The roasting serves to facilitate the removal of the husks, and to develop the aroma and flavor.

On account of the peculiar properties of the cocoa bean, its preparations merit a place on our tables for two reasons. In addition to being, like tea and coffee, the material for the preparation of a pleasant and exhilarating beverage, it is a valuable food material; not only is it much richer in nutritive substances than tea or coffee, but both the soluble and insoluble portions become a part of the beverage, while only the constituents soluble in hot water are obtained in the beverages prepared from tea and coffee. The food value of cocoa preparations has, however, been greatly overestimated, and many of the present modes of preparation do not develop in the highest degree possible the pleasing aroma and flavor. The inventive energy of many manufacturers seems to be spent on the production of a supposed highly nutritive and easily digestible preparation; the valuable fat is removed and the delicious aroma and flavor destroyed by chemicals for the ostensible purpose of rendering more digestible a residue of doubtful food value.

The more important constituents of the husked cocoa bean are fat, theobromin, the nonalkaloidal nitrogenous substances, starch, the coloring matter called cocoa-red, and the mineral matter.

The fat, cocoa or cacao butter, in consequence of its quality and peculiar excellence, is unquestionably the constituent of the cocoa bean possessing the highest food value. It usually forms 45 per cent to 55 per cent of the husked bean, rarely falls below 45 per cent, and only one recent analysis shows as low as 36 per cent. At ordinary temperatures it is white or slightly yellowish, having a pleasing taste and odor, and showing but little tendency to become rancid. Its melting point being below the temperature of the body, insures its being presented in liquid form to the action of the digestive juices. The low melting point, the little tendency to become rancid, and other properties, render cocoa butter peculiarly suitable for the basis of many pharmaceutical preparations. This by-product of the manufacture of cocoa preparations has, therefore, a well-established place in commerce.

Theobromin, the alkaloid of cocoa, is very closely related chemically to caffein, the alkaloid of tea and coffee, and has similar effects on the system, the power possessed by the beverages prepared from these substances "to cheer and not inebriate" being largely due to the presence of these alkaloids. Separated from the bean, it is a white powder, permanent in air, crystallizable in microscopic needles, and having a bitter taste. The husked bean contains 1.28 per cent to 2.40 per cent of theobromin and the husk 0.42 per cent to 1.11 per cent. Its unimportance commercially at present offers no temptation to remove it from cocoa preparations before placing them on the market. Small percentages of caffein have been found in cocoa beans and somewhat larger percentages in the husk.

The nitrogenous nonalkaloidal portions of the cocoa bean belong to several classes. They amount in all to from 12 to 20 per cent of the entire substance. About one-half of these bodies are digestible. Their food value has doubtless been much overestimated.

Cocoa contains 5.78 per cent to 15.13 per cent of starch. It occurs in small well-characterized grains that are not easily confused with other starches when examined microscopically.

Cocoa-red, the coloring matter of the bean, seems to be related to the tannin or astringent principle also present, but authorities differ as to whether it is a decomposition product of a tannin, or whether a tannin is the result of its decomposition.

Small percentages of a gum and of tartaric acid have been reported. The aroma of cocoa is considered to be due to the presence of minute quantities of an aromatic volatile oil.

The preparations of cocoa are so numerous that more or less confusion of terms naturally arises. Most American manufacturers prepare a plain chocolate (known in Europe as cacao-masse), made by reducing the roasted and husked beans to a paste and pressing into form of cakes. When this is combined with much or little sugar (generally much), vanilla, and spices, the various "sweet," "vanilla sweet," "vanilla," "spiced," etc., chocolates are produced. These are also usually met in the form of cakes, but are sometimes pulverized and sold as "powdered" chocolates. The high percentage of fat renders a permanent powder impossible without its partial removal or the addition of some diluent, as sugar, starch, or flour. The preparations in powder known as "cocoas," "bromas," etc., are prepared in accordance with one or the other, or a combination of these methods.

Cocoa husks are offered on the market in bulk and in packages, but their use seems to be quite limited at present.

Perhaps no food material offers conditions so favorable for profitable adulteration and so well utilized by its manufacturers as do cocoa preparations. There is probably no more misleading or more abused term in the English language than "soluble cocoa." No cocoa in the market contains more than 10 per cent to 30 per cent of matter soluble in water unless the material so dissolved is foreign soluble material that has been added during the process of preparation. The term seems to be used to denote a preparation that allows none of the insoluble matter to deposit from the beverage prepared from it. This purpose may be accomplished in two ways; the material may be so finely divided that a very long time will be required for its deposition, or foreign substances (as starch or sugar) may be added to render the liquid of so high specific gravity or so pasty that the insoluble matter will not deposit. The first method is decidedly to be preferred; it accomplishes the object in view and puts the preparation in better condition for the action of the digestive juices, and all this without the addition of a cheap diluent that is always at hand in every kitchen should its use be desired. Any additions of this kind should be considered adulteration unless their nature and quantity are accurately stated.

Attempts at the preparation of easily "digestible cocoas" (preparations to which pepsin or other digestive ferments have been added do not come in question here, since the favorable condition of the preparation is not involved, but the supplying of a deficiency in the strength of the digestive juices) seem to fail in purpose and to be attended with the introduction of objectionable substances. The use of alkalis for this purpose is quite generally regarded as injurious to health, and the effect is the opposite of that desired.

The removal of the fat is not considered an adulteration when it is acknowledged, and it is undoubtedly desirable for persons with weak digestion. It seems important, however, that the public have a means of knowing accurately to what extent it has been removed. It also seems desirable that the percentage of sugar be accurately stated. The adulterants added are reported to be, besides starches and sugar, substances of organic and inorganic origin to increase the weight and

bulk, ferruginous and other pigments to restore the color of highly diluted preparations, and foreign fats to restore the normal percentage of fat, or to give the preparation the plasticity required for molding. The husk, because of its coarse nature and consequent tendency to act as an irritating substance in the alimentary canal, and in consequence of its poverty in the constituents that render cocoa valuable, is regarded as an adulterant when not removed, or when added to increase the weight or bulk of the preparation.

Sixty-two samples of cocoa preparations have been submitted to microscopical and chemical examination in the laboratory of the Department of Agriculture. A brief summary of the results of these investigations is presented in the following table:

Number of samples.	Character of samples.	Number of samples containing large additions of starch or flour.	Number of samples containing very large amounts of cocoa husks.	Number of samples containing sugar.			
				20 to 30 per cent.	44.7 per cent.	50 to 60 per cent.	60 to 71.9 per cent.
6	Plain chocolates	4					
29	Sweet chocolates	11	8			21	8
27	Cocoas, bromas, etc	12	6	7	1	3	
62	Totals	27	14	7	1	24	8

For further details concerning the adulterations of tea, coffee, and chocolate, reference is made to Bulletin 13 of the Division of Chemistry, part VII (in press), which contains the full work of which the foregoing is a brief extract.

REPORT OF THE CHIEF OF THE DIVISION OF FORESTRY.

SIR: I have the honor to submit my sixth annual report upon the work of the Division of Forestry, together with a discussion of a few subjects of general interest which occupied the attention of the division during the year 1891.

Very respectfully,

B. E. FERNOW, *Chief.*

Hon. J. M. RUSK, *Secretary.*

INTRODUCTORY.

The past year has witnessed greater activity and interest in forestry matters than any previous one, due especially to the enactment of a law by Congress authorizing the President to set aside public timber lands for permanent forest reservations, and perhaps due also to an increase in the diffusion of information as to the practical importance and meaning of forest management. This better and more general appreciation of the objects and methods of forestry may, in part at least, be traced to the activity of this division, and more directly to the comparatively wide distribution of Bulletin No. 5, entitled "What is Forestry?" of which 25,000 copies were sent out to farmers, lumbermen, and others interested in forestry matters.

In this bulletin it was shown that the forestry interests of this country rank second, if not first, in the value of our annual products reaching the market, rivaling our agricultural production, and leaving far behind in value of product any single manufacture and many important interests or manufactures combined. The principles which underlie proper management of forest resources and those which apply to successful forest planting in the prairies are also outlined in this publication.

The largest share of the expenditure of funds as well as of the attention devoted to any particular work has been bestowed upon investigations into the character of our timber trees, which were discussed more in detail in my last report under the caption of "Timber Tests." This caption, however, does not fully indicate the exact nature of the work in hand. While the testing of the timbers appears as the most conspicuous part of the work, and the more careful determination of average values expressing the strength of our wood materials is looked for with eagerness by architects, builders, engineeers, and consumers of wood, these features constitute in reality the smaller part and by no means the ultimate object of the undertaking. This object is a twofold one, namely, first, to find out in what relation the mechanical properties of timber stand to its structure and physical conditions, and thereby to find for

practice means of judging mechanical properties from a simple microscopic or macroscopic examination; and, secondly, to find out in what relation structure, physical conditions, and mechanical properties stand to the conditions under which the tree is grown, and thereby to obtain knowledge for the forest-grower as to the kinds of timber which will yield the best results in given soil and climatic conditions.

Forestry is by no means satisfied with the growing of trees, but is concerned also with the production of material of given quality. In the virgin forests species are found growing in widely varying conditions and hence of widely varying quality, but it can not be the object of forest management to follow nature in this particular. It must also determine under what conditions the best or the most serviceable quality of a given species is produced, and must encourage the production of the species under such conditions alone.

During the year there have been collected in the manner described, partly tested, and examined, 22 trees of white pine from Wisconsin, 23 trees of longleaf pine (*P. palustris*), 10 trees of shortleaf pine (*P. echinata*), 15 trees of loblolly pine (*P. Tæda*), and 59 trees of various species of oak from Alabama. Besides, there were collected and partly tested and examined for the purpose of determining the influence of tapping for turpentine upon the quality of longleaf pine, 8 trees "boxed" and abandoned for five years, and 11 trees boxed and just abandoned; or altogether 149 trees, furnishing not less than 3,000 to 4,000 test and examination pieces. In addition, a series of tests to determine the influence of different degrees and methods of seasoning has been inaugurated.

So far this large amount of work has been possible under the always scantily measured appropriations for this division only through the courtesy of railroad companies in transporting test material free of charge; through the energy of Prof. J. B. Johnson in supplying all the needed testing apparatus, including a large beam and column testing machine, and in organizing the test work; and through the zeal and economical work of Dr. Charles Mohr and Mr. Filibert Roth in collecting and examining the material. To carry on this work expeditiously and most economically, an expenditure of not less than $40,000 per year should be allowed, this amount being based on the assumption that one competent man should be employed at the testing machines all the year. In three or four years data would thus be accumulated sufficient to employ for some time to come competent workers, who are to elaborate the laws of relation—the ultimate object of the undertaking.

A preliminary bulletin on this work in timber physics is now ready for the press, and will presumably be published before this report reaches the public, giving a historical review of similar work attempted before, and describing in detail the character of the present work, the methods and machinery used in testing, with illustrations, and the manner in which the physical examination is carried on.

If appropriations permit, it is planned to publish results three or four times in the year, in order to bring them as quickly as possible into the hands of those who need the data for practical application.

That there is a widespread and deep interest in this work, unique in the annals of this country, and almost in the world (the Prussian Government having just started out on a similar plan), is manifested by the reprint in full in many technical journals of Circular 7, describing briefly the methods pursued, and also by a large number of letters received by the Department from leading engineers, architects, lumbermen, and scientific societies, expressing appreciation, and pointing out

the great need of rapid progress of a work which will save millions of expenditure and direct and indirect losses which the country suffers from our ignorance as to the true values and strength of our building timbers. I may be allowed to quote from one of the many letters a striking passage, which opens the vista of the benefits to be derived, and also emphasizes the fact that our present knowledge in this direction is a "state of ignorance." Mr. D. H. Burnham, engineer of construction for the World's Columbian Exposition, writes: "When I was appointed engineer of construction, World's Columbian Exposition, August 1, I found it necessary to make changes in most of the buildings because I did not dare to use as high unit stress in timber as was used by my predecessor, although he claimed to be perfectly safe in his strains, and brought forward authorities—Trautwine and others—to prove his statements."

In connection with this work it became desirable to study, from a mercantile point of view, the lumber pines of the Southern States, which are taking a more and more prominent place among our building materials. It was found that such misconceptions existed among lumber-dealers, architects, and engineers regarding these pines, and their names as well as character, as to make it not an easy task to unravel the existing confusion. The result of these studies is given farther on in this report, and will, it is hoped, afford more light upon the subject of the pine lumber supply of the South than has hitherto been accessible.

The revision of both the botanical and the common names of our arborescent flora, a work in special charge of the botanist of the division, has progressed during the year until it is nearly completed and will soon be ready for publication. Owing to the many other duties of office routine which must be attended to, all such work must necessarily progress slowly. Meanwhile the study material in the herbarium, wood collection, seed collection, bud collection, and bibliography is growing constantly; and correspondence, asking for advice in the most widely different fields, is increasing daily, consuming so much time of the divisional force that a large accumulation of valuable manuscript remains unpublished for lack of opportunity to prepare it editorially for the press.

SEED DISTRIBUTION.

The distribution of tree seeds for 1891 was made up of two disbursements: 100 pounds to forty State experiment stations and 300 pounds to general applicants. To the first, 300 packages of nine important conifers, varying in quantity per package from 2 ounces to 1 pound, were distributed, with letters of advice and directions as to the best method of handling seed received and reporting results. A general disposition to coöperate in this work has been expressed by nearly all directors of experiment stations, and also a desire to receive material so assigned in future, and a willingness to report upon the success of experiments with the same.

To about 400 general applicants—ranging over forty-nine States and Territories—were distributed a total number of 5,000 packages of tree seeds, including twenty species of important conifers and deciduous trees. According to the locality, each applicant has received from twelve to fifteen packages, each containing from half an ounce to 2 ounces of seed.

In addition to the above, five hundred 2-ounce packages of *Acacia decurrens* (Australian tanbark wattle) has been lately distributed to a

few applicants in the Gulf States, but chiefly to parties in the arid Southwest and the southern part of the Pacific coast region.

The small plantation of osier willows established in the Department grounds in 1889 furnished 1,500 cuttings, of thirty different kinds, which were distributed to about 150 applicants, and a second small plantation of newly imported material has been started.

In regard to the distribution of plant material, I have submitted every year my opinion that, with such appropriations as are at the disposal of this division, the distribution can hardly accomplish the object for which it was intended, namely, to encourage forest-planting, which means planting of masses. When the introduction of exotic or native species for trial in special localities is intended, this can be satisfactorily done only by experimenters who have experience and time to devote to the work, such, for instance, as may usually be found at the agricultural experiment stations. The applicants who expect to be supplied with plant material of tried sorts for 5 or 10 acre plantations are, therefore, always disappointed with the few small trial packages, which are all the division is able to send. Yet, as long as the law requires it, this demand must be satisfied, albeit with small benefit.

As a part of this distribution of plant material, rather than a bona fide experiment of the division, I have been enabled to plan and direct a forest-planting experiment, which is described farther on.

RAINFALL EXPERIMENTS.

Since the appropriations for experiments in the production of artificial rainfall were technically included with those for this division, the writer may be allowed to explain his position toward these experiments, especially as his name has appeared before the public in connection therewith in daily papers and in his report for the year 1890. In that report, while admitting that experiments in this direction would not necessarily be devoid of merit if conducted upon a careful scientific plan, the writer took the position that our present knowledge of meteorological forces and conditions does not warrant an assumption of results from the methods which it was proposed to pursue, and he was, therefore, excused from planning or conducting the experiments.

WATER MANAGEMENT THE PROBLEM OF THE FUTURE.

Before even attempting the control of precipitation, our studies, in the opinion of the writer, should be directed to secure better management of the water supplies as they are precipitated and become available by natural causes. How poorly we understand the use of these supplies is evidenced yearly by destructive freshets and floods, with the accompanying washing of soil, followed by droughts, low waters, and deterioration of agricultural lands.

It may be thought heterodox, but it is nevertheless true, that the manner in which most of the water of the atmosphere becomes available for human use (namely, in the form of rain) is by no means the most satisfactory, not only on account of the irregularity in time and quantity, but also on account of its detrimental mechanical action in falling; for in the fall it compacts the ground, impeding percolation. A large amount of what would be carried off by underground drainage is thus changed into surface-drainage waters. At the same time by this compacting of the soil capillary action is increased and evaporation thereby accelerated. These surface waters also loosen rocks and

soil, carrying these in their descent into the river courses and valleys, thus increasing dangers of high floods and destroying favorable cultural conditions.

Here it is that water management, and, in connection with it or as a part of it, forest management, should be studied; for without forest management no rational water management is possible. The forest floor reduces or prevents the injurious mechanical action of the rain, and acts as a regulator of waterflow. Hitherto water management in rainy districts has mainly concerned itself with getting rid of the water as fast as possible, instead of making it do service during its temporary availability by means of proper soil management, horizontal ditches, and reservoirs—drainage and irrigation systems combined. It seems to have been entirely overlooked that irrigation, which has been considered only for arid and subarid regions, is to be applied for plant production in well-watered regions with equal benefit and profit, if combined with proper drainage systems and forest management. To pave the way for a better utilization of water supplies in the Eastern States seems as much a proper function for the Department of Agriculture as the development of irrigation systems in the Western States; and a comprehensive collection of water statistics and forestry statistics with reference to their mutual relation seems to be a desirable task for the coöperation of various branches of this Department and the State agricultural stations.

On this subject the following communication was received by the Department, presenting a resolution passed by the American Association for the Advancement of Science, at the Washington meeting:

To the Secretary of Agriculture:

SIR: The A. A. A. S. respectfully submits for the consideration of the Secretary of Agriculture that the future of successful and more productive agriculture depends very largely upon a rational *water management*, meaning thereby not only the use of water for irrigation in the arid and subarid regions, but the rational distribution and use, in the humid regions, of available water supplies by means of horizontal ditches and irrigation systems combined with proper mechanical preparation of the soil and with drainage systems, with the object of fully utilizing the water for plant production and providing for the safe and harmless removal of the surplus.

The present policy of forest destruction and of allowing our waters to run to waste not only entails the loss of their beneficial influence upon plant production, but permits them to injure crops, to wash the fertile mold from the soil, and even to erase and carry away the soil itself.

It is upon these considerations that the association respectfully suggests to the honorable Secretary the desirability of utilizing the Weather Bureau, the various agricultural experiment stations, and other forces, in forming a systematic service of water statistics and in making a careful survey of the condition of water supplies, which may serve as a basis for the application of rational principles of water management.

ALBERT B. PRESCOTT,
President.
F. W. PUTNAM,
Permanent Secretary, A. A. A. S.

WASHINGTON, D. C., *August 25, 1891.*

FORESTRY LECTURES.

The increased interest in forestry matters has manifested itself also by the frequent calls for addresses, lectures, etc., before various conventions, and by inquiries from professors at agricultural colleges and other institutions for text-books in forestry and for advice in arranging for lectures. Early in the year the writer was asked to devise a regular course of lectures, and to give the initial lecture at the University of Nebraska, at Lincoln. To meet similar requests from various sources

the following scheme, for 100 lectures, comprising more or less fully the whole field of forestry in a condensed form, for expansion or contraction, according to the needs of the teacher or his pupils, has been devised, a fuller elaboration of which is to form the subject of a special publication.

SCHEME OF ONE HUNDRED FORESTRY LECTURES.

A. Introductory; in four lectures:
- (1) What is a forest?
- (2) The forest as a resource.
- (3) The forest as a condition.
- (4) The object of forestry and its methods in general.

B. Forest botany and soil physics; in twenty-four lectures:
- (5) General review of descriptive botany relating to trees and shrubs.
- (6) Classification of arborescent and shrubby flora.
- (7) The conifers in particular.
- (8) The broadleaved trees in particular.
- (9) Plant physiology: Processes of growth.
- (10) The mechanism of a tree.
- (11) Conditions upon which tree growth depends.
- (12) Soils, their composition, origin, and character.
- (13) Trees and soil in interrelation.
- (14) Climate, factors of, and conditions influencing it.
- (15) Trees and climate in interrelation.
- (16) Trees in interrelation of each other.
- (17) Distribution of species, general philosophy.
- (18) Distribution of forest areas.
- (19) The weeds of the forest and their significance.

C. Forest planting; in fifteen lectures:
- (20) Seeds, their nature and keeping.
- (21) The seed-bed; methods of raising seedlings.
- (22) The seedling nursery.
- (23) Preparation of soil for forest planting.
- (24) Sowing or planting?
- (25) Selection and arrangement of plant material.
- (26) Methods of planting in general.
- (27) Methods under special conditions.
- (28) After culture.
- (29) Natural reforestation by seed and from the stump.

D. Forest management; in twelve lectures:
- (30) Cultivation, its value and methods.
- (31) Filling.
- (32) Thinning.
- (33) Pruning.
- (34) Undergrowing.
- (35) The timber forest.
- (36) The coppice.
- (37) The standard coppice.
- (38) Method of "selection" and other methods.
- (39) Special consideration of important species.

E. Forest protection and survey; in eight lectures:
- (40) Forest description, survey, districting, etc.
- (41) Roadmaking and facilities of transportation.
- (42) Injurious influences in general.
- (43) Protection against fire.
- (44) Insects, their depredation, prevention, and protection.

F. Forest regulations and forestry mathematics; in twelve lectures:
- (45) General ideas regarding a regulated system of forest management.
- (46) The mathematics of tree growth; annual accretion in height and diameter.
- (47) The mathematics of forest growth; annual and periodical accretion in masses.
- (48) The financial mathematics of forest growth, quality and value.
- (49) Calculation of yield, yearly and periodical cut, rotation, reserves.
- (50) Methods of forest regulation.

G. Timber physics and technology; in fifteen lectures:
- (51) Anatomy of woods.

G. Timber physics and technology; in fifteen lectures—Continued.
- (52) Chemical physiology of timber and trees.
- (53) Physical properties.
- (54) Mechanical properties.
- (55) Influences determining properties.
- (56) Diseases and faults.
- (57) Methods of harvesting the crop.
- (58) Adaptation of various timbers for use.
- (59) Methods of preparing wood materials for use.
- (60) By-products and their harvest.

H. Forest policy and history; in ten lectures.
- (61) Forest influences upon climate.
- (62) Forest influences upon soil.
- (63) Forest and general development.
- (64) Government policy regarding forests.
- (65) History of forestry development in foreign countries.
- (66) The forests of the United States.
- (67) Development of forestry in the United States.
- (68) The needs of forestry in the United States.

STATISTICS OF EXPORTS AND IMPORTS OF WOOD AND WOOD PRODUCTS.

The customary tabulation of statistics of forest products, compiled from the reports of the Bureau of Statistics, is herewith subjoined.

Of these tables, that representing the exports by regions will be found of novel interest. In the case of New York and Philadelphia, in the first group of ports, the exports can not, perhaps, all be credited to the Northern tier of States, some Southern timber finding its outlet through these ports. We find that the Southern exports from the Gulf and from the Atlantic coast south of Baltimore nearly equal, or, with proper allowance for the influence of the two ports mentioned, probably more than equal, that of the Northern ports. It will also be noticed that over 50 per cent of the Northern exports are manufactures, while those from the South represent less than 10 per cent of manufactured articles. When comparing Gulf ports and South Atlantic ports, the advantage as far as export of manufactures is concerned is strongly in favor of the former. The building of railroad cars seems to be best developed in that region.

From the table of average export prices it will be seen that no striking changes are noticeable during the last ten years; there were about as many rises as falls during the period, unevenly distributed for different materials.

Exports of wood and wood products from the United States for the twelve months ending June 30, 1890 and 1891.

Articles.	1890.		1891.	
	Quantity.	Value.	Quantity.	Value.
Agricultural implements:				
Horse powers		$3,474		$7,616
Mowers and reapers		2,092,638		1,579,976
Plows and cultivators		878,874		596,728
All other, and parts of		884,288		1,034,810
Bark and extract of, for tanning		263,754		241,382
Carriages and horse cars		2,056,980		2,015,870
Cars for steam railroads ... number	3,662	2,689,698	3,902	2,885,250
Ginseng ... pounds	223,113	605,233	283,000	959,992
Organs ... number	11,490	750,583	14,498	954,507
Matches		62,284		73,220
Rosin ... barrels	1,601,377	2,762,373	1,790,251	3,467,199
Tar ... do	28,806	56,105	17,265	39,094
Turpentine and pitch ... do	18,327	35,037	68,066	17,180
Spirits of turpentine ... gallons	11,248,920	4,590,931	12,184,057	4,668,140

Exports of wood and wood products, etc.—Continued.

Articles.	1890.		1891.	
	Quantity.	Value.	Quantity.	Value.
Firewood .... cords..	7,648	$16,746	2,061	$7,026
Boards, deals, and planks .... M feet..	612,814	9,974,888	613,613	9,916,945
Joists and scantling .... do..	26,684	381,640	11,117	155,114
Hoops and hoop poles	....	59,978	....	60,502
Laths .... M..	10,491	24,951	7,976	20,799
Palings, pickets, and bed slats .... M..	2,981	30,653	1,352	13,479
Shingles .... M..	36,527	111,926	42,463	116,868
Shooks:				
Box	....	118,557	....	199,674
Other .... number..	534,190	766,607	316,242	450,492
Staves and headings	....	2,476,857	....	2,404,213
All other lumber	....	1,355,141	....	886,133
Timber:				
Sawed .... M feet..	270,984	3,384,847	214,612	2,549,411
Hewn .... cubic feet..	8,732,761	1,381,747	6,800,173	1,227,960
Logs and other round timber	....	1,680,346	....	2,274,102
Doors, sash, and blinds	....	320,840	....	338,263
Moldings, trimmings, and other house finishings	....	116,295	....	140,670
Hogsheads and barrels, empty	....	425,278	....	240,430
Household furniture	....	3,088,902	....	2,956,114
Wooden ware	....	360,515	....	387,823
All other wood manufactures	....	2,197,815	....	1,924,022
Total	....	46,006,781	....	44,811,004

Imports of wood and certain wood products for home consumption during the years ending June 30, 1890 and 1891.

Articles.	1890.		1891.	
	Quantities.	Values.	Quantities.	Values.
Free of Duty.				
Firewood .... cords..	153,667	$320,882	....	$360,090
Logs and round timber	....	945,022	....	1,272,427
Railroad ties .... number..	2,228,059	444,513	2,287,411	399,411
Shingle and stave bolts	....	108,855	....	89,198
Handle and head bolts	....	4,498	....	72,530
Ship timber	....	90,931	....	81,159
Ship planking	....	34,997	....	30,761
Hop poles	....	1,386	....	11,562
Wood for pulp making	....	100,443	....	130,747
Charcoal	....	50,073	....	56,669
Cabinet woods: Cedar, ebony, mahogany, etc	....	1,527,154	....	1,802,703
Corkwood or bark	....	1,213,876	....	1,249,008
Hemlock bark .... cords..	35,023	163,673	57,254	274,426
Bamboos, rattans, canes, etc	....	763,188	....	1,080,258
Ashes	....	40,098	....	42,624
Dutiable.				
Wood, unmanufactured, not specially provided for..	....	11,169	....	11,455
Timber—				
Used for spars .... cubic feet..	....	218	1,207	153
Hewn and sawed .... do....	....	759	526,968	34,952
Squared or sided, not specially provided for .... cubic feet..	29,796	9,643	117,782	35,947
Boards, planks, deals, and other sawed lumber .... M feet..	41,385	382,242	373,373	4,240,145
All other sawed lumber, not otherwise specified .... M feet..	538,618	6,342,474	325,967	3,576,638
Clapboards .... M..	4,908	75,672	5,588	88,254
Hubs, posts, lasts, and other rough blocks	....	48,345	....	50,828
Laths .... M..	308,545	361,375	293,142	345,602
Pickets and palings .... M..	8,161	38,896	15,856	66,597
Shingles .... M..	194,921	414,346	259,897	553,274
Shooks	....	150,916	....	107,586
Staves	....	427,998	....	438,063
Casks and barrels, empty	....	632	....	1,545
Barrels or boxes containing oranges, lemons, etc., apart from the value of the contents*	....	....	....	522,368

* Comparison of this item with other years can not be given, as such barrels and boxes have been dutiable for the first time under the tariff act of 1890.

Imports of wood and certain wood products, etc.—Continued.

Articles.	1890.		1891.	
	Quantities.	Values.	Quantities.	Values.
Dutiable—Continued.				
Cabinet ware and household furniture	....	$520,313	....	$453,041
Osier or willow, prepared for manufacture	....	27,646	....	93,207
Osier or willow, manufactures of	....	372,356	....	223,335
Wood pulp ..... pounds	93,042,340	1,773,388	97,026,890	1,902,689
Carriages and parts of	....	452,884	....	....
Bark, extract, for tanning ..... pounds	....	709	....	15,187
Sumac ..... do	18,806,487	376,784	13,811,325	544,396
Corks and cork bark, manufactured	....	343,734	....	432,055
Matches	....	44,059	....	88,066
Frames and sticks for umbrellas	....	81,504	....	91,754
All other manufactures of wood, or of which wood is the component of chief value	....	516,622	....	901,475
Total	....	18,634,273	....	21,772,185

Annual average export prices of wood and certain wood products for each of the ten years ending June 30, from 1882 to 1891.

Articles.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.
Wood and manufactures of:										
Boards, deals, and planks ..... M feet	$16.90	$16.78	$17.06	$15.93	$15.20	$15.38	$16.39	$16.99	$16.28	$16.17
Joists and scantling ..... do	......	......	15.44	14.06	13.97	14.67	15.16	13.37	14.30	13.70
Laths, palings, pickets, bed slats, etc ..... M	......	......	2.43	2.13	2.71	2.39	2.57	2.44	2.38	2.61
Shingles ..... M	3.07	3.04	2.96	2.90	2.45	2.63	3.07	2.89	3.06	2.75
Firewood ..... cord	3.99	3.60	3.58	3.20	3.15	3.10	3.32	2.72	2.27	3.41
Timber, sawed ..... M feet	......	......	11.17	10.50	10.82	11.79	12.41	12.38	12.49	11.88
Timber, hewn ..... cub. ft	......	......	.16	.15	.16	.16	.17	.18	.16	.18
Naval stores:										
Rosin ..... barrels	......	......	1.83	1.73	1.74	1.69	1.53	1.49	1.72	1.94
Tar ..... do	......	......	2.10	1.77	1.90	1.94	1.96	1.90	1.95	2.26
Turpentine and pitch ..... barrels	......	......	2.23	1.85	2.48	2.08	1.74	1.81	1.91	2.01
Spirits of turpentine ..... gallons	.47	.44	.34	.30	.34	.34	.34	.39	.41	.38

*Exports of wood and certain wood products during the year ending June 30, 1891, by districts of country whence exported.**

	Districts.				
	I.	II.	III.	IV.	Total.
Raw materials:	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
Boards, deals, planks, etc	3,184,201	1,886,810	3,373,790	1,472,144	9,916,945
Joists and scantling	21,332	54,882	78,341	559	155,114
Hoops and hoop poles	52,728	7,774	....	....	60,502
Laths	4,053	123	321	16,302	20,799
Palings and pickets	....	450	174	12,855	13,479
Shingles	13,937	47,396	12,799	42,736	116,868
Shooks	601,287	15,673	699	32,507	650,166
Staves	923,164	602,642	876,987	1,420	2,404,213
All other lumber	584,114	79,694	128,468	93,857	886,133
Timber (sawed)	55,281	291,850	1,680,304	521,976	2,549,411
Timber (hewn)	622,360	43,608	561,342	650	1,227,960
Logs and other round timber	1,217,631	784,213	227,496	44,762	2,274,102
Firewood	7,026	....	....	....	7,026
Rosin	731,440	2,732,702	2,919	138	3,467,199
Tar	24,610	11,744	369	2,571	39,094
Turpentine and pitch	15,501	1,296	374	9	17,180
Spirits of turpentine	474,373	4,188,208	879	4,590	4,668,140
Bark and bark extract	63,060	178,322	....	....	241,382
Total raw materials	8,596,098	10,927,387	6,945,262	2,246,876	28,715,713

* District No. 1 includes all of the United States north of Baltimore and east of the Rocky Mountains. District No. 2 includes the territory having its outlet by the South Atlantic ports District No. 3 includes the territory adjacent to the Gulf ports. District No. 4 embraces that portion of the United States bordering on the Pacific Ocean.

Exports of wood and certain wood products during the year, etc.—Continued.

	Districts. I.	II.	III.	IV.	V.
Manufactures:	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
Agricultural implements	3, 077, 132	33, 418	66, 064	42, 516	3, 219, 130
Carriages and horse cars	1, 784, 915	7, 594	100, 288	123, 073	2, 015, 870
Cars, passenger and freight	2, 157, 372	110, 235	543, 191	74, 452	2, 885, 250
Matches	55, 538	15	2, 023	15, 644	73, 220
Organs	917, 069	32, 120	820	4, 498	954, 507
Doors, sash, and blinds	201, 120	4, 408	22, 254	110, 481	338, 263
Moldings, trimmings, etc	115, 810	1, 566	780	22, 514	140, 670
Hogsheads and barrels, empty	236, 743	540	1, 077	2, 070	240, 430
Household furniture	2, 638, 272	22, 295	85, 788	209, 759	2, 956, 114
Wooden ware	337, 219	49, 172	1, 371	61	387, 823
All other wood manufactures	1, 605, 593	227, 242	63, 165	28, 022	1, 924, 022
Total manufactures	13, 126, 783	488, 605	886, 821	633, 090	15, 135, 299
Total exports	21, 722, 881	11, 415, 992	7, 832, 083	2, 879, 966	43, 851, 012

POISONING OF STREET TREES.

There are many inquiries referred to the division on subjects not strictly belonging to forestry but to arboriculture in general; in fact, anything pertaining to tree life seems to be considered as falling under the scope of this division. Among recent inquiries of this character is the following, the reply to which, being of wide interest, may with propriety be here reproduced.

It had been observed in Cleveland, Ohio, that the street and lawn trees, in which the city takes particular pride, were dying, and the mayor and council of the city called upon the Department to ascertain the cause. Prof. J. C. Arthur, of Purdue University, Indiana, being an expert biologist and in Washington at the time, was commissioned to act as an agent of the Department, and on his passage through Cleveland to examine the condition of the trees and their surroundings. From his report and an additional report of the present writer, the following summing up of the case may be made, which will bear also upon similar cases in other cities.

It is a well-known fact that trees in modern cities, especially street trees, do not always find the most suitable conditions. Not only does the pavement and rapid drainage, which for other reasons is desirable and must be provided for, reduce available moisture supplies and impede aeration of the roots, but the trees are liable to various injuries, all of which conditions are apt to reduce their vigor and vitality. It is therefore necessary, first of all, to select for city planting trees which best endure such unfavorable conditions. Besides these unavoidable drawbacks to tree life in cities, there exist additional dangers where leaks from gas pipes saturate and poison the soil near the roots, and where, as in Cleveland, soft coal is burned in large quantities, from the sulphurous acid accompanying the smoke from such coal.

From Prof. Arthur's examination it appeared that the injuries to the trees which were dying did not proceed from the roots, and therefore had to be sought in the condition of the atmosphere. Subsequent correspondence, however, developed the fact that in localities where drainage and other conditions are favorable to tree growth the trees did not die in spite of the neighborhood of iron industries giving rise to much smoke; which fact only goes to show that under otherwise favorable conditions trees, when unimpaired in their vigor, are able to resist the poisoning influence of the gases.

Prof. Arthur's opinion, then, may be accepted as properly explaining the cause of the destruction, and I quote from his report as follows:

> After giving due weight to the dryness of the soil, to the possible presence of illuminating gas in the soil, and to the discharge of gases in the air incident to the extensive manufacture of chemicals, some further cause must be sought for the unusual destruction of the shade trees of Cleveland, and such cause is to be found in the smoke from the large manufacturing establishments, and especially from the oil refineries.
>
> The action of smoke is twofold—mechanical and chemical. The mechanical action consists in excluding the light from the green cells of the leaf, and thereby preventing the formation of organic matter for the nutrition of the plant. In proportion as the light is excluded the plant languishes. The clouds of smoke that float above the tree temporarily cut off part of the light, and the coating of soot over the surface of the leaf acts continuously. Dust has a similar action, but is a less powerful absorbent of light, and is consequently less injurious. Rough-leaved trees suffer most, as the soot and dust are less readily removed by wind and rain.
>
> The chemical action of the smoke arises mainly or entirely from the presence of certain gases, which act as poisons. It has been found by Morren (Proc. Intern. Hort. Exhib. in London, 1886) that carbon monoxide, which arises from the incomplete combustion of coal, is not harmful to plants. Arsenic, in the form of arsenious acid, has been shown to be present sometimes in coal smoke, but it does not appear to be especially injurious. Fluoric acid has recently been proven (Forst- u. Jagdzeitung, 1891, p. 220) to seriously injure trees in the vicinity of establishments on the Rhine which manufacture fertilizers containing soluble phosphoric acid. I am unable, however, to give any opinion regarding the possible presence of fluoric acid in the air of Cleveland.
>
> Probably the most injurious gas accompanying smoke from coal and rock oil is sulphurous acid. It has been shown by Morren to injure plants if the air contains but one part in 50,000. More recent experiments by Schroeder (Bot. Centralb., 1883, p. 368) make it certain that even one part in a million is harmful. Although I have no direct evidence of the presence of sulphurous acid in the Cleveland atmosphere, yet from the well-known abundance of sulphur in American soft coal and crude petroleum, there can be no reasonable doubt that it occurs in sufficient amount to largely or wholly account for the destruction of the trees.
>
> Insect pests appeared to be less abundant in Cleveland than elsewhere; even the cottony scale of the maples, which has been so destructive in other cities, was only seen a few times, and only in harmless numbers. I think that insects have no important part in causing the death of the trees.

The only exception that may be taken to Prof. Arthur's statement is that the mechanical effect of the soot settling upon the leaves, while undoubtedly not favorable to the function of the leaves, is yet hardly to be mentioned as a cause of injury in comparison with that due to the acid poisoning. At least experiments made abroad would show the former damage hardly noticeable—the latter, on the contrary, easily determinable.

Frequent suits for damages have led in Europe to a careful study of the effects of these gases, to the establishment of special methods for determining the connection between cause and effect, and to remedial legislation.

The gases, which penetrate the leaves, not through the stomata, but by osmosis over the entire surface, act injuriously, directly by poisoning and indirectly by destroying the balance between water supply and transpiration, the sulphurous acid desiccating and destroying the tissues of the leaf.

But the principal question is that of a remedy. No practical method of preventing the effects can be suggested as long as the smoke nuisance continues. Remedial action lies, therefore, only in two directions: either to prevent the escape of the noxious gases or else to plant only such trees as are exempt, or partially so, from ill effects of the gases.

High chimneys have not proved themselves altogether effective, but smoke-washing devices and methods of neutralizing the acids by the use of milk of lime or condensation to sulphuric acid have been found practi-

cable enough to permit in England such legislation as places chimneys under police control and imposes fines upon the owner who permits the escape of black smoke. The smoke washing is a very simple and inexpensive operation, requiring nothing but a series of U-shaped flumes, through which the smoke is made to pass under a sprinkle of water. Charcoal may also be employed to condense the gas.

In some cities the establishment of factories is limited to certain districts, most suitably in the lee of the prevailing winds.

As regards the choice of trees which would withstand best the influence of the gases, it may be said that where the smoke nuisance is excessive none will survive. The conifers suffer most. Of deciduous trees the alder, which can hardly be considered a desirable street tree, and the sycamore, seem hardiest; next come the poplars, the ash, and the linden, and the very ornamental mountain ash, which deserves more attention than it has as yet received. As to the elm, experiences seem to differ; probably otherwise very favorable conditions of growth, which, however, are rarely found in cities, may enable it to resist the effects of the smoke. The Norway maple seems to excel our American kinds in smoke-resisting quality. Ailanthus, horse chestnut, and black locust are also mentioned as available. I am inclined to add to the list of those probably capable of resisting acid poisoning the sweet gum or liquidambar, which in every respect is one of the most commendable street trees, and also the tulip poplar.

I may add that if effective measures were taken at once to suppress the smoke nuisance, it would probably be possible to save, by judicious pruning, such trees as are not too badly affected and have retained vigor enough to make new growth.

Of course, before the city authorities will act in such a matter, a more thorough examination by competent chemists and fuller report upon practicable means of averting the damage would be necessary.

I can not leave this subject, of growing importance to many other cities besides Cleveland, Pittsburg, Cincinnati, St. Louis, etc., without pointing out, first, the need for these cities to consider the disadvantages, not only to plant life, but to human health and life, which arise from the unrestricted contamination of the air by the smoke nuisance, quite unnecessarily, and, second, the desirability of having the tree-planting in the streets and public grounds superintended and carefully directed by competent men. When it is considered that the maintenance of the parks and street trees of Washington involves an annual expenditure of over $125,000, or the interest on $2,500,000, the importance, from a mere financial point of view, of guarding this most valuable health-promoting property against avoidable injurious influences becomes clear.

The city of Cleveland, beautiful and attractive through its verdure of luxuriant trees, may well be alarmed at her loss, and stand ready to guard her trees with jealous care.

In this connection I would refer those interested in tree-planting in cities to a very suggestive article by the well-known professor of botany, H. Marshall Ward, on "A Model City, or Reformed London," in the New Review for August, 1891.

A NATIONAL ARBORETUM.

Speaking of tree-planting in cities, I am led to renew my recommendation for the establishment of a national arboretum at Washington, as a matter of desirable improvement. The climate of this city is

exceptionally favorable, so that the largest range of species can be readily accommodated, exceeding that found in the celebrated Kew Gardens of England. The main object of an arboretum, I may add, is not, as has sometimes been mistakenly supposed, to study landscape effects and incidentally to introduce some instructive features, but it must be, primarily and mainly, to serve the purpose of instruction. Hence, while it may be possible, with sufficient space, to arrange an arboretum without neglecting landscape effects, this must not be one of the leading ideas in its establishment. On the other hand, the range of its usefulness as a means of instruction should be correspondingly enlarged beyond that of a living herbarium, so as to embody not merely trials but also experiments on acclimation, and to permit the study both of form and landscape features of the different species, their rate of growth, and ultimately their behavior toward one another when merged into a forestry experiment.

To advance this movement in the interest of arboriculture the American Association for the Advancement of Science, at its Washington meeting transmitted the following resolution to the President of the United States Senate and to the Speaker of the House of Representatives:

Whereas the arborescent flora of the United States excels in variety of useful plants that of any country of the earth under one Government;

Whereas the District of Columbia and the capital of the nation are climatically so situated that nearly all the species of the North, South, East, and West may be grown there in the open, or with a minimum of protection;

Whereas the interest in arboriculture and forestry, although growing rapidly, requires an advancement of knowledge and still more the fostering care of the Government;

Whereas the capital is destined to become a center of learning and instruction to all classes of the people, and the accumulation of means of education and opportunities of increasing knowledge here is most desirable;

Now, the American Association for the Advancement of Science respectfully submits to the Congress of the United States the propriety of creating an arboretum in or near the District of Columbia, to be established under the direction of the Department of Agriculture, and asks that a sufficient appropriation be made for such an establishment at once, and further appropriations for its continuance.

BAMBOO AS A SUBSTITUTE FOR WOOD.

The discussion of waning wood supplies, which has formed a part of the stock in trade of forestry reformers, naturally leads to a search for substitutes which will either permit reduced consumption or more rapidly replace exhausted supplies. It was to meet this phase of the discussion on forestry matters that the division published Bulletin 4, on the Substitution of Metal for Wood in Railroad Ties, and for the same reason the following brief discussion on the bamboo and similar materials, as possible substitutes for wood, is here given at the special request of the Assistant Secretary of this Department. In connection therewith will be found a letter of the United States consul to Sicily, Mr. Charles Heath, on the advisability of introducing into the United States the well-known bamboo, *Arundo donax* L., a native of South America, southern Europe, Egypt, and the East, doubtless one of the more important of the species for economic purposes. The following notes are taken from his letter:

Thoroughly naturalized in Sicily, where it is not affected by slight frost, and recommended for introduction in the United States as far north as New York, it will doubtless prove hardy throughout California and the Southern States.

Sicilian farmers consider this cane the best paying crop, and grow it abundantly on otherwise worthless wet land, utilizing borders of fields, brooks, swamp holes, etc.

Arundo donax is a perennial plant, dying to the ground each year and producing new canes in the spring, propagated entirely from root cuttings—a rooting joint or eyes.

Merchantable canes are produced in one year and a plantation yields for a dozen years, requiring no cultivation after planting. A single plant gives five or six canes 30 feet long, the stock becoming stouter each year. The dried canes have a large sale, being very light, stiff, durable, and furnishing material for fencing, roofing, canes, fish-poles, hop, grape, and bean poles; split, they are used for lath, woven hampers, baskets, etc.

The tribe Bambusæ (bamboos) belongs to the true grass family, Gramineæ, and comprises about twenty genera with nearly two hundred species, of which the genus Bambusa may be considered the type. The bamboos are mostly confined to warmer regions, sometimes growing at elevations of 10,000 to 15,000 feet.

About fifteen genera, of which Bambusa, Arundinaria, Arundo, Dendrocalamus, and Guadua are the most important, constitute the more or less arborescent and tall cane-like forms of the tribe. Of the genus Bambusa, perhaps the most important economically, there are about forty-six species, mostly arborescent. Thirty of these are Old World forms, fifteen South American, and one species occurs in Africa. A single species, *Bambusa vulgaris*, is cosmopolitan and widely distributed by cultivation.

The genus Arundinaria, economically important, contains about twenty species, two of which (*A. macrosperma* and *A. tecta*) are the only canes growing native in North America, occurring in the Southern States and northern Mexico, the *A. macrosperma* forming the canebrakes of Florida. The remaining species range through South America and Asia (Japan and Himalayas). The allied genus Arundo has about seven species, tall canes, one of which, *A. donax*, is highly esteemed as a useful plant. It belongs naturally to South America, southern Europe, Egypt, and the East, but by cultivation has become widely distributed.

The bamboos differ from the common herbaceous grasses, with which they are classed in general, only in having tall or arborescent, stiff, woody, siliceous stems, hollow between the many joints. In size the bamboos range from 10 to 150 feet in height and from 1 inch to 2 feet in diameter.

Economically the bamboos supply chiefly construction, textile, and food material. The seed of many species resembles rice, especially when cooked, having about the same market value; a few species having berry-like fruit. The uses to which bamboo stems, leaves, etc., are put are almost innumerable. Principal among them, in warmer climates, are those for the building of houses, bridges, and fences; also for the making of masts, rafts, water pipes, ship rigging, carts, furniture, boxes, baskets, hampers, mats, cordage, paper, etc. The young tender shoots are often cut for fodder; and the shoots of one or two Japanese species are cooked and eaten as asparagus.

In the United States, so far as known, the bamboos are as yet only planted for ornament. Nearly all the arborescent kinds are more or less known in cultivation; and of these there are about twenty well-known species grown for ornament and as useful plants.

Of the sixty indigenous species of the Chinese Empire, only six or seven are cultivated for economic purposes. *Bambusa matake* and *B. arundinacea* are most esteemed in Japan.

Besides the two native canes of the Southern States, there are at least ten important exotic bamboos from China, Japan, and the Himalayas, wheih may reasonably be expected to thrive in the milder parts

of the United States; and two of these (*Bambusa matake* and *Arundinaria Japonica*) have been found to be hardy even in New England climate.

According to Mr. H. C. Ford, of Santa Barbara, to whom credit is due for some of the information contained in this paper, a number of successful bamboo plantations have already been established in southern California; that of Gen. R. W. Kirkham, of Oakland, of plants originally introduced from China, is twenty-four years old, making a growth of as much as 35 feet in one season. Mr. H. H. Berger, of San Francisco, imported a number of choice kinds from Japan, cuttings or sprouts from which were subsequently distributed through the State University experimental garden. The Indian bamboo, *Bambusa arundinacea*, attaining a height of 50 feet, is also successfully grown in sheltered positions in the State; and it is attested by one California grower to be capable of enduring 6 degrees of frost, the roots resisting a zero temperature. At the semitropical exhibition at Ocala, Fla., a fine collection of bamboo stems large enough for fence rails was exhibited from Lee County, Fla.

The bamboos have a wide distribution climatically, and range in altitude from the sea level to 10,000 or 15,000 feet (Himalayas). They appear to flourish best in warm, moist climates, although in many cases, especially in regions subject to drought, they seek shaded ravines and valleys with a cool atmosphere. For best development they require a deep, moist, loose, rich soil. Protection against rapid evaporation of soil moisture in sandy soils is highly important in the early growth of a plantation. A wet soil, however, is not essential.

Doubtless few extra-tropical plants indicate, in their ability to endure the rigors of their native climates, greater chance of successful introduction into this country than the bamboos. A number of the Asiatic species are said to occur naturally as far north as parallel 40, and at Yokohama and Yeddo, where a foot of snow and 2 inches of ice are not uncommon. At Hong-Kong species grow high up in the hill country, though mostly in moist, cool valleys and ravines, which is an indication that in general these plants flourish best in regions with abundant rainfall—at least with periodic rainfall. These conditions may doubtless be supplied, as is already done in southern California, by proper irrigation, particularly in the drier Southwest, where these plants must be regarded as a desirable accession.

The bamboos are gregarious in habit, numerous stems arising in dense impenetrable masses; and as the shoots and mature canes are cut down from year to year new shoots constantly spring up. The height and diameter growth of the arborescent kinds is often remarkably rapid and large. With an Indian species (*Dendrocalamus giganteus*), the growth is phenomenal, being known to reach 40 feet in as many days. A record is given for even 2 to 2½ feet in a day. Gen. Kirkham has a record of 8 inches per day attained in his California plantation. According to the species, the mature stems are 10 to 150 feet in height.

The myriad uses found for bamboos in China, Japan, and other regions require a greater supply than can be derived from natural propagation. Supplies of bamboo seed for planting are difficult to obtain, as the plants seed rarely, sometimes not oftener than every twenty-five or even sixty years, and a few of the most useful kinds grown in Japan are said never to seed. The seeds, moreover, are exceedingly difficult to germinate; hence plants are propagated almost entirely from root cuttings, eyes, and offsets.

The year before plants are needed for transplanting, old established plants, which should not be younger than four years, are thus treated:

The main stem is cut back (to about 6 to 8 feet in height); also the side shoots, if any, are moderately trimmed. The shallow horizontal roots are cut off from the mother plant at a short distance from the stem. A narrow trench is then cut on each side of the plant down to the root level and filled with a rich phosphate compost, and the plant is left till the following spring, when, with sufficient newly formed roots, it may be successfully transplanted to a permanent site—best in rows 12 feet apart and the plants 2 feet apart in the row. Plants thus set out should be 2 to 4 inches deeper in the ground than originally grown. Care also should be taken to brace the stems newly set out, to prevent them from being uprooted by wind.

The roots severed from the mother plant are left in the ground undisturbed, as they soon throw up new shoots, which in about three years become sufficiently established to be treated for transplanting, as in the case of the parent plants.

But little care is given to a bamboo plantation once established, beyond general cultivation during the first two or three years.

The experience of Japanese bamboo-growers is that mature stems are best harvested in September, in order to avoid the destructive ravages of a beetle which soon attacks the canes cut at other seasons of the year.

FOREST-PLANTING EXPERIMENTS.

Since taking charge of this division, and for the first time inspecting the attempts at forest-planting on the treeless plains, the writer has contended that essential changes in methods were necessary before successful and satisfactory forest-planting could be accomplished in that region. Not only did he consider the choice and arrangement of plant material faulty, but also the methods of planting, which were advised and pursued without regard to differences in soil conditions. In spite of all the experience through failure and success that thirty years of tree-planting on the plains and prairies may have brought, we can not say that as far as planting for forest purposes is concerned sufficient experimental knowledge has been gained to determine the best methods, for the reason that, so far as known at this office, no real forest-planting experiments have anywhere been undertaken with a view of ascertaining such methods by comparison.

For such comparison it is necessary to observe plantations originated expressly for the purpose under various methods, at the same time, under the same conditions, and with the same material, and to keep close watch over them for some time. This division has never been and is not now in a position to carry on such experiments, but almost accidentally last spring an opportunity was offered to plan and in part direct a forest-planting experiment on the sand hills of Nebraska; and although many drawbacks occurred, since part of the plant material was received in bad order, personal supervision could not be given to the work, and the plans could not be carried out fully as conceived, an account of the attempts may, nevertheless, prove of interest and value to those who may hereafter model experiments under more favorable auspices.

The attempt at such experiment was the result of a visit to Lincoln, Nebr., on the occasion of several addresses which the writer had been called upon to deliver, and the manner in which it was arranged will most readily appear from the recital of the contract under which the owner of certain lands in the sand-hill region of Holt County, Nebr., undertook it. The contract reads as follows:

In consideration of a certain amount of plant material for forest purposes placed at my disposal by the Department of Agriculture, through the Division of Forestry, I promise to use the same in the manner indicated by the chief of the Forestry Division, furnishing all the land and labor free of charge, and giving such protection and personal attention as may be necessary to make this experimental planting successful. And I further promise to allow the management of this plantation to be controlled by the Department of Agriculture for not less than five years, or so much of that time as may seem necessary to pass the plantation beyond the experimental stage, without any further consideration.

In moving westward from the Mississippi or the Red River of the North a series of more or less distinct benches or sudden changes of level may be noticed, and each new higher plain thus outlined is less favorable to agriculture than the preceding. In Nebraska, on one of these rises, and also on the borders of river valleys, are rolling "sand hills" scantily clothed with bunch and other grasses hardly sufficient to keep the sands in stable condition. Cultivation is out of the question, for as soon as the scanty sod is broken the winds drift the sands, either covering or uprooting whatever crop may be planted. In such a location, southwestern Holt County, Nebr., our experimental plantation has been started, following the principle that forests should be assigned to nonagricultural lands, and realizing that should planting on these sand hills be successful this region will be greatly benefited by such success.

The following considerations served as the basis for the experiments:

(1) The best plant material for the dry plains, and especially the sand hills, are conifers, and of these more especially the pines. Not only are there indications that the sand hills were originally covered with a growth of the bull-pine (*Pinus ponderosa*), but, wherever planted, the Scotch and Austrian pines, as soon as once established, have grown thriftily, and are rarely injured by heat, cold, or drought. The difficulty of first establishing them can no doubt be overcome by proper methods.

(2) The best results are always to be expected from a carefully selected and arranged mixture of species, either all coniferous, or, preferably, conifers with deciduous trees; selection and arrangement to be made with the principles in view which are detailed in Bulletin No. 5.

(3) Dense planting—*i. e.*, rapid shading of the ground—is the secret of success in forest-planting, and mulching is preferable to cultivating, if it can be done cheaply. What the most satisfactory spacing is can only be determined by trial for each species and local condition.

(4) A soil like that of the sand hills should be as little disturbed as possible, since it is apt to blow when plowed. If funds and opportunity had permitted the employment of hand labor, one plat would have been set out with the dibble, carefully avoiding disturbance of the soil.

(5) The bane of tree growth on the plains are the cold and the hot winds, both dry, and hence constantly sapping the life of the plants. There should, therefore, be established before any attempt at planting on a large scale, wind-breaks of rapid-growing kinds which will endure the winds. It was not possible to wait for such a wind-break to grow, but the material—5,000 cuttings of white willow—was ordered to be planted simultaneously. Unfortunately these cuttings arrived in too poor condition to be of use, and hence the plantation has remained without this protection.

With these preliminary remarks and the additional explanation that the conception and execution of the experiment took place rather late in spring, making it necessary to prepare for it at short notice, the following instructions which were issued to the planters will be understood and appreciated:

INSTRUCTIONS FOR A FOREST-PLANTING EXPERIMENT ON THE SAND HILLS IN NEBRASKA.

(1) *Objects of experiment.*—The object of this experimental planting is to test the adaptability of various conifers for forest-planting on the Western plains and especially in the sand-hill region of Nebraska, and also to find out whether or not dense planting, without special preparation and cultivation of the soil, is preferable to wider spacing with cultivation. It is also intended to compare the success of mulched with that of unmulched parts, and the behavior of various combinations of kinds in varying widths of planting.

(2) *Location of experimental plats.*—The experimental plats are to be located on a northeast-to-east exposure of a hill of medium slope, which also offers all other exposures for further use, if desired. Set aside two acres, more or less, for the first year's planting, running the base line along the ravine or valley about 400 yards and the line up the hill 24 yards so that four plats of 100 x 24 yards (equal one half-acre each) can be had, numbering them 1 to 4, beginning with the northernmost. If the hill is such that the plats can be made to cross over the top of the hill without great difference in measurements, they may be made to conform to the location. The base line should be above any land desirable for agricultural use. The neighborhood of a stream of living water is desirable.

When planting, leave a rod or so of ground between plats to serve as a mark and to permit the use of a plow on each plat without disturbing the next one.

(3) *Protection and preparation of plats.*—Surround the plats by a fire-break, a wind-break on northwest and southwest side (or north, west, and south), and, if there is danger of cattle running at large, a fence. The wind-break is to be made of two rows of willows, setting the cuttings 2 feet apart in the rows, the first row one-half rod from the outer row of trees, and the second row 4 rods outside of the first. The fire-break is to be made by plowing, before fire will run, two strips of two furrows each, 4 rods apart outside of the wind-breaks and around the entire tract, then as early as possible burning over the intermediate space. Plats 1, 2, and 3 are not to receive any treatment previous to planting, unless it be necessary to cut grass or weed growth. Plat 4 is to be plowed 12 inches deep, as for an agricultural crop, a week or so before planting.

(4) *Plant material.*—To understand the disposal of the plant material, it may be remarked that the conifers are to be the dominant growth, and among them *Pinus ponderosa* (bull-pine) is expected ultimately to prevail. *Pinus sylvestris* (Scotch pine) is considered next in importance, but may attain its growth and require cutting out sooner than the former.

The bull-pine has been chosen because there are indications that originally this region was occupied by that species; the Scotch and Austrian pine because experience has proved them perfectly hardy and of satisfactory growth in Nebraska. The latter is especially valuable for its soil improving capacity.

P. Banksiana (Banksian pine) comes next in importance; it is on trial for the situation, without any previous indication as to its adaptation, and, if successful, may also be utilized before the bull-pine. The seedlings of the Banksian pine dug from the forest may not have as good a chance as nursery-grown. Hence, for comparison, a few nursery-grown plants of this pine are also planted. The same remarks apply to *P. resinosa* (red pine), only that if found successful in the situation it would rank equivalent to bull-pine. The few plants of *Thuya occidentalis* (arbor vitæ) are for trial as a nurse or soil cover, and *Pseudotsuga taxifolia* (Douglas spruce), one of the most valuable timber trees of the West, to test its adaptation to the locality.

The deciduous-leaved trees are mainly to serve as filling; the black locust and birch to be cut as necessary for thinning; the box-elder and hackberry are intended for additional soil cover; the black cherry and red oak are on trial for permanent mixture, as valuable timber trees likely to succeed under the existing conditions.

(5) *Treatment of plant material when received.*—The plants will be sent from various directions. Their treatment before planting is of as much importance as that which they receive during the planting. As soon as the plants arrive they should be taken out of the package or box in a cool and shady place (cellar, if possible), and the roots buried in moist soil. For convenience in handling them afterwards, it might be best to dispose them, each kind separately, in boxes, which, soil and all, can be taken into the field when planting. Above all things else, the roots must be kept moist and strictly covered until placed in the ground. On this care depends largely the success in planting.

While unpacking, examine the plants, and report by return mail what their condition was in regard to—

(*a*) Whether the fibers were found dry;
(*b*) Whether roots are bruised and broken—if so, how much?
(*c*) Whether tops are bruised and broken—if so, how much?

(*d*) What are the smallest, largest, and average sizes, estimating the proportion of each?

(*e*) The general conditions and appearance of packages and plants.

While making this examination, remove with sharp shears any broken or badly bruised parts and shorten roots if necessary to 12 inches or thereabout, cutting as little as possible.

On the day of planting, carry the plants, or as many as can be disposed of in a day, to the plats in boxes or in pails, the roots covered with moist soil and protected against the sun by oil cloth or otherwise, using also moistened gunny sacks and sphagnum moss for the purpose. It is best, before moving to the ground, to arrange the plants needed for each plat in bunches, keeping the bunches separate, so as to avoid unnecessary handling in the open field.

(6) *Manner of planting.*—The best time for planting is on rainy and damp days, and, if possible, when ground is somewhat wet. If such days can not, be awaited, the more care must be taken to keep the rootlets protected against drying during the planting, especially those of the conifers.

For this purpose prepare a puddle by mixing muck or black loam with water to the consistency of a very thin batter, in a bucket, and transfer into it from the supply the plants needed for a row, or as many of them as can be conveniently handled, so that the roots are covered with the puddle and the heads free from it. Whenever more than one distinct kind is planted in the row, a pail for each kind will be necessary.

Open a furrow 12 inches deep across the slope of the hill the length of the plot. Immediately following the plow let one man set the plants before the ground has time to dry, taking one at a time from the pail. The plants must be set slightly deeper than they were in the nursery, the soil drawn around them with hand or trowel and tightly packed around the roots, using hand and foot. Tight contact between the soil and root is the secret of successful planting.

The distance apart can be measured by the eye and no special marking is necessary, being careful to keep distance as nearly equal as possible.

Do not plow a second furrow until the first is planted.

In setting the plants always begin the alternate rows with the first plant set in half the distance between plants, thus:

```
First row.................................# ........ # ........ #
Second row..............................        # ........ #
Third row.................................# ........ # ........ #
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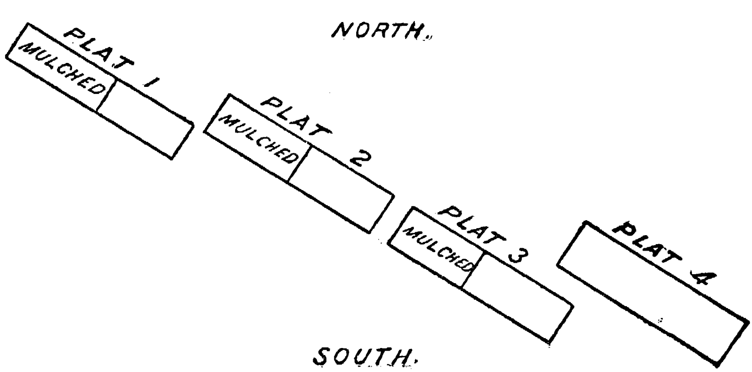
(7) *After-treatment.*—Mulch, at once after planting, one-half of plats 1, 2, 3 with straw, hay, or other litter, so that it will be about 2 inches deep after settling. Apply the mulch to the northernmost half, running up and down the hill.

Plat 4 is to be cultivated as for a corn crop at least four times during the season.

The plats are of course to be watched and properly protected against dangers, and especially is the fire-break to be kept clean by timely burning of the grass or weeds.

(8) *Reports.*—On or near the 15th of October of every year make a more detailed examination and report on the number of trees living, their growth, the amount of cover they make, and the general comparative showing of the different plats.

Position of plats.



DISPOSAL OF PLANT MATERIAL.

Plat 1.—This, the northernmost, is to contain a combination of three pines; rows 2 feet apart; plants 2 feet in the row.

First row—Banksian pine and every third plant bull-pine.
Second row—Scotch pine, or red pine, or Douglas spruce, or arbor-vitæ.
Third row—Banksian pine.
Fourth row—Scotch pine and every third plant Austrian pine.
Fifth row—Banksian pine.
Sixth row—Scotch pine, or red pine, or arbor-vitæ.
Seventh row.—Like first, and so on.

Plat 2.—This plat is to contain a combination of bull-pine with Austrian pine and with deciduous trees. Rows 2 feet apart, plants 2 feet in the row, disposed as in diagram.

First row—Black locust and every fourth tree bull-pine.
Second row—Box-elder, or hackberry, or cherry.
Third row—Like first, and so on.

Plat 3.—This plat is to consist of equal parts bull-pine, Austrian pine, and black locust or other deciduous trees; rows 3 feet apart, plants 2 feet in row.

First row—Bull-pine and every second tree locust, every third tree Austrian pine.
Second row—All locust, or birch, or cherry.
Third row—Like first, and so on.

Plat 4.—To be planted mainly to conifers at greater distances and to be cultivated afterward.

Rows 4 feet apart, plants 3 feet in the row. Bull-pine every third tree, with balance of conifers used indiscriminately, and deciduous trees in every fifth row.

Report on condition of plantation October 15, 1891.

PLAT 1.

Species.	Condition in which received.	Number planted.	Number living Oct. 15, 1891.	Per cent living Oct. 15, 1891.
Bull-pine	Good	306	139	45.4
Banksian pine	Fair	2,362	2,055	87.0
Scotch pine	Poor to fair	1,350	23	01.7
Austrian pine	Good	300	134	44.7
Red pine	...do	375	54	14.4
Douglas spruce	Poor to fair	200	53	17.7
Arbor-vitæ	Fair	225	110	48.9
Total		5,218	2,568	49.2

PLAT 2.

Bull-pine	Good	459	144	31.4
Austrian pine	...do	450	187	41.6
Locust	Poor	1,809	1,604	88.7
Box-elder	...do	1,800	109	06.1
Hackberry	Good	450	212	47.1
Cherry	Poor to fair	450	34	07.6
Total		5,418	2,290	42.3

PLAT 3.

Bull-pine	Good	288	91	39.9
Austrian Pine	...do	2,222	99	44.6
Locust	Poor	2,191	1,903	86.9
Scotch pine	Poor to fair	228	1	00.4
Douglas spruce	...do	222	30	13.5
Oak	Good	41	7	17.1
Box-elder	Poor	25	3	12.0
Hackberry	Good	50	44	88.0
Total		3,207	2,178	67.9

Report on condition of plantation October 15, 1891—Continued.

PLAT 4.

Species.	Condition in which received.	Number planted.	Number living Oct. 15, 1891.	Per cent living Oct. 15, 1891.
Bull-pine	Good	1,017	111	10.9
Red pine	....do	74	8	10.3
Scotch pine	Poor to fair	666	1	2
Box-elder	Poor	675	3	4
Oak	Good	159	8	5.0
Total		2,591	131	5.1

Summary of report of October 15, 1891.

Plat No.	How planted.	No. planted.	No. living.	Per cent living.
1	Pines, 2 feet apart, in sod, one-half mulched	5,218	2,568	49.2
2	Bull-pine, with deciduous trees, 2 feet apart, in sod, one-half mulched	5,418	2,290	42.3
3	Pines and deciduous trees, 2 by 3 feet apart, in sod, one-half mulched	3,207	2,178	67.9
4	Mixed planting on plowed ground, 3 by 4 feet apart, to be cultivated. (The last planted, and during very dry weather.)	2,591	131	5.1
	Total	16,434	7,167	43.6

REMARKS.

(*a*) No perceptible difference was noted between the mulched and the unmulched parts.

(*b*) The weather during May was extremely dry; June and July very wet; August neither dry nor wet; September dry, except a few days in latter part; October dry.

It would be premature to draw many or any conclusions from an experiment of such short duration and carried on under so many drawbacks. Indications and inferences only may be ventured upon.

The failure of certain of the trees does not necessarily indicate that they are not suitable. I am inclined to lay the blame on the handling of the material from the nursery to the plantation. On the other hand, the eminent success of the black locust, although reported to be received in poor condition, and of the Banksian pine, dug from the forest in Wisconsin, seem proof positive that they are readily started under the given conditions. The indication also is that dense planting produces better results the first season than wider spacing with cultivation.

It is proposed to fill out vacant places and continue the experiment.

SOUTHERN LUMBER PINES.

There are in the Southern Atlantic and Gulf States ten species of pine which are or can be cut into lumber. Two of these, the white pine (*Pinus Strobus* L.) and the pitch-pine, also called yellow or black pine (*Pinus rigida* Mill.) occur only in small bodies on the Allegheny Mountains from Virginia down to northern Georgia, being rather Northern pines. Three, the Jersey or scrub-pine, occasionally also called shortleaf or spruce-pine (*Pinus virginiana* Mill.) along the coast to South Carolina; the sand, scrub, or spruce-pine [*Pinus clausa* (Engelm.), Sarg.] found in a few localities in Florida, and the pond, also called loblolly or Savannah pine (*Pinus serotina* Mx.) along the coast from North Carolina down to Florida, occur either so sparingly that they do not cut any figure on the lumber market or do not often produce sizeable trees for sawlogs.

There remain, then, five distinctly Southern species which are actually cut for lumber; one of these, the spruce-pine, also called cedar pine or white pine (*Pinus glabra* Walt.), probably does not reach the market except by accident. But the other four may be found now in all the leading markets of the East.

It is for the purpose of clearing up the almost inextricable confusion and misconceptions which seem to exist in regard to the identity of these pines and their lumber among millmen, dealers, architects, engineers, and the public at large, that the following attempt has been made to furnish a reliable diagnosis.

The confusion arises mainly from an indiscriminate use of local names and from ignorance as to the differences in characteristics of their lumber as well as the difficulty in describing these. Besides the names used in designating different species, there are names used by lumbermen to designate differences of quality in the same species and, in addition, names used in the markets without good distinction, until it becomes almost impossible to unravel the multiplicity of designations and define their meaning. Architects are apt to specify "Southern pine," not knowing that the greatest range of qualities can be supplied under that name; or refuse to accept "Texas" or "North Carolina pine" for "Georgia pine," although the same pine and quality can be furnished from either State. Dealers handle "longleaf pine" from Arkansas, where the timber that is understood by that name never grew. Millmen fill their orders for this pine, either overlooking differences or without knowing them.

The following table of common names, which have been found applied to the four species furnishing Southern pine lumber, will most readily exhibit the difficulty arising from misapprehension of names. These names are used in the various markets and in various localities in the home of the trees. Where possible the locality in which the name is used has been placed in brackets by the side of the name.

Names of Southern lumber pines in use.

Botanical names.	*Pinus palustris* Miller. Syn. *P. australis* Michx.	*Pinus echinata* Miller. Syn. *Pinus mitis* Michx. *Pinus virginiana* var. *echinata* Du Roi. *P. Tæda* var. *variabilis* Aiton. *P. variabilis* Lamb. *P. rigida* Porcher.
Best common names. Local, market, and lumbermen's names.	LONGLEAF PINE: Southern yellow pine. Southern hard pine. Southern heart-pine. Southern pitch-pine. Hard pine (Miss., La.). Heart pine (N. C. and So. Atlantic). Pitch-pine (Atlantic). Long-leaved yellow pine (Atlantic). Long-leaved pine (Atlantic). Long-leaved pitch-pine (Atlantic). Long-straw pine (Atlantic). North Carolina pitch-pine. Georgia yellow pine. Georgia pine. Georgia heart pine. Georgia long-leaved pine. Georiga pitch-pine. Florida yellow pine. Florida pine. Florida long-leaved pine. Texas yellow pine. Texas long-leaved pine.	SHORTLEAF PINE: Yellow pine (N. C., Va.). Short-leaved yellow pine. Short-leaved pine. Virginia yellow pine (in part). North Carolina yellow pine (in part.) North Carolina pine (in part). Carolina pine (in part). Slash-pine (N. C., Va.), in part. Old-field pine (Ala., Miss.). Bull-pine (?). Spruce-pine.

Names of Southern lumber pines in use—Continued.

Botanical names.	*Pinus Tæda* Linn. Syn. *Pinus Tæda* var. *tenuifolia* Aiton.	*Pinus cubensis* Griesebach. Syn. *Pinus Tæda* var. *heterophylla* Ell. *P. Elliotii* Engelm. *P. cubensis* var. *terthrocarpa* Wright.
Best common names. Local, market, and lumbermen's names.	LOBLOLLY-PINE: Slash-pine (Va., N. C.), in part. Loblolly-pine (Gulf Region). Old-field pine (Gulf Region). Rosemary-pine (N. C., Va.). Short-leaved pine (Va., N.C., S. C.). Bull-pine (Texas and Gulf Region). Virginia pine. Sap-pine (Va., N. C.). Meadow pine (Fla.). Cornstalk pine (Va.). Black pine (Va.). Fox-tail pine (Va., Md.) Indian pine (Va., N. C.). Spruce-pine (Va.), in part. Bastard pine (Va., N. C.). Yellow pine (No. Ala., N.C.). Swamp pine (Va., N. C.). Long-straw pine (Va., N. C.), in part.	CUBAN PINE: Slash-pine (Ga., Fla.). Swamp pine (Fla. and Ala.), in part. Bastard pine (Fla., Ala.). Meadow pine (Fla., E. Miss.), in part. She pitch-pine (Ga.).

Before attempting to unravel the mystery of this synonymy, and of its confused application in the field and markets, we will attempt to elucidate what in reality these pines are by giving a botanical description, an account of their field of distribution and habitat, manner of growth, and a diagnosis of their wood.

Botanical diagnosis.

Species.	*Pinus palustris* Miller.	*Pinus cubensis* Griseb.
Leaves	3 in a bundle, 9 to 12 (exceptionally 14 to 15) inches long.	2 and 3 in a bundle; 7 to 12 (usually 9 to 10) inches long.
Cones (open)	6 to 9 inches long, $4\frac{1}{2}$ to 5 inches in diameter.	4 to $6\frac{1}{2}$ (usually 4 to 5) inches long; 3 to $4\frac{3}{4}$ inches in diameter.
Scales	$\frac{7}{8}$ to 1 inch broad; tips much wrinkled, light chestnut brown, gray with age.	$\frac{11}{16}$ to $\frac{7}{8}$ inch broad; tips, wrinkled; deep russet brown; shiny.
Prickles	Very short, delicate, incurved	Very short; straight; declined.
Buds	$\frac{3}{4}$ inch long, $\frac{1}{2}$ inch in diameter; silver white.	About $\frac{1}{2}$ inch long; $\frac{1}{4}$ inch in diameter; brownish.

Species.	*Pinus echinata* Miller.	*Pinus Tæda* Linn.
Leaves	2 and 3 in a bundle; $1\frac{3}{8}$ to 4 inches long; commonly $2\frac{1}{2}$ to 4 inches.	3 in a bundle; 5 to 8 inches long.
Cones (open)	$1\frac{1}{4}$ to 2 inches long; $1\frac{1}{8}$ to $1\frac{3}{4}$ inches in diameter.	$2\frac{1}{2}$ to $4\frac{1}{2}$ inches long; $1\frac{3}{4}$ to 3 inches in diameter.
Scales	$\frac{5}{16}$ to $\frac{3}{8}$ (exceptionally about $\frac{1}{2}$) inch broad; tips light yellow-brown.	$\frac{3}{8}$ to $\frac{3}{4}$ inch broad; tips smooth; dull yellow-brown.
Prickles	Exceedingly short ($\frac{1}{10}$ inch) delicate; straight, declined.	Short; stout at base.
Buds	$\frac{3}{8}$ to $\frac{1}{2}$ inch long; about $\frac{1}{8}$ inch in diameter; brownish.	$\frac{1}{2}$ to $\frac{3}{4}$ inch long; $\frac{1}{4}$ inch in diameter; brownish.

In aspect and habit the longleaf and Cuban pine somewhat resemble each other. The large silvery white buds of the longleaf pine, which constitutes its most striking character, and the candelabra-like naked branches with brush-like tufts of foliage at the end readily dis-

tinguish it from the Cuban pine, which bears a fuller and denser crown. The dark green, glossy, and heavy foliage of the latter readily distinguishes this again from the loblolly, where these may appear associated, the latter having sea-green and thinner foliage.

As a rule the Cuban pine grows taller (up to 110 or 115 feet, with a diameter of 2½ to 3 feet) than the longleaf, which rarely exceeds 105 feet and 20 to 36 inches in diameter. The Cuban pine forms massive horizontally spreading limbs, and at maturity a crown with rounded outlines; the longleaf pine forms a more flattened crown with massive but twisted gnarled limbs, which are sparingly branched.

The thin bark of the longleaf (only one-quarter to one-half inch thick), of uniform reddish brown color throughout, exfoliates in thin, almost transparent, rhombic flakes; the thick bark of the Cuban pine of the same color exfoliates in very thin, broad, purplish flakes.

The shortleaf pine is readily distinguished by the comparatively shorter and more scant appearance of its foliage. Moreover, this species is at once recognized by its characteristically small cones. Its habit is spreading, if compared with the more ascending, compact habit of the loblolly. At maturity the shortleaf has a much shorter bole (85 to 95 feet, diameter 1½ to 2 feet) than the loblolly (125 to 150 feet, diameter 4 to 5 feet), with which it is often associated, and a more pyramid-shaped crown.

The reddish bark of the shortleaf in mature trees is broken into long plates, while the loblolly bark appears of grayish color and breaks into broader, larger, and more deeply fissured plates.

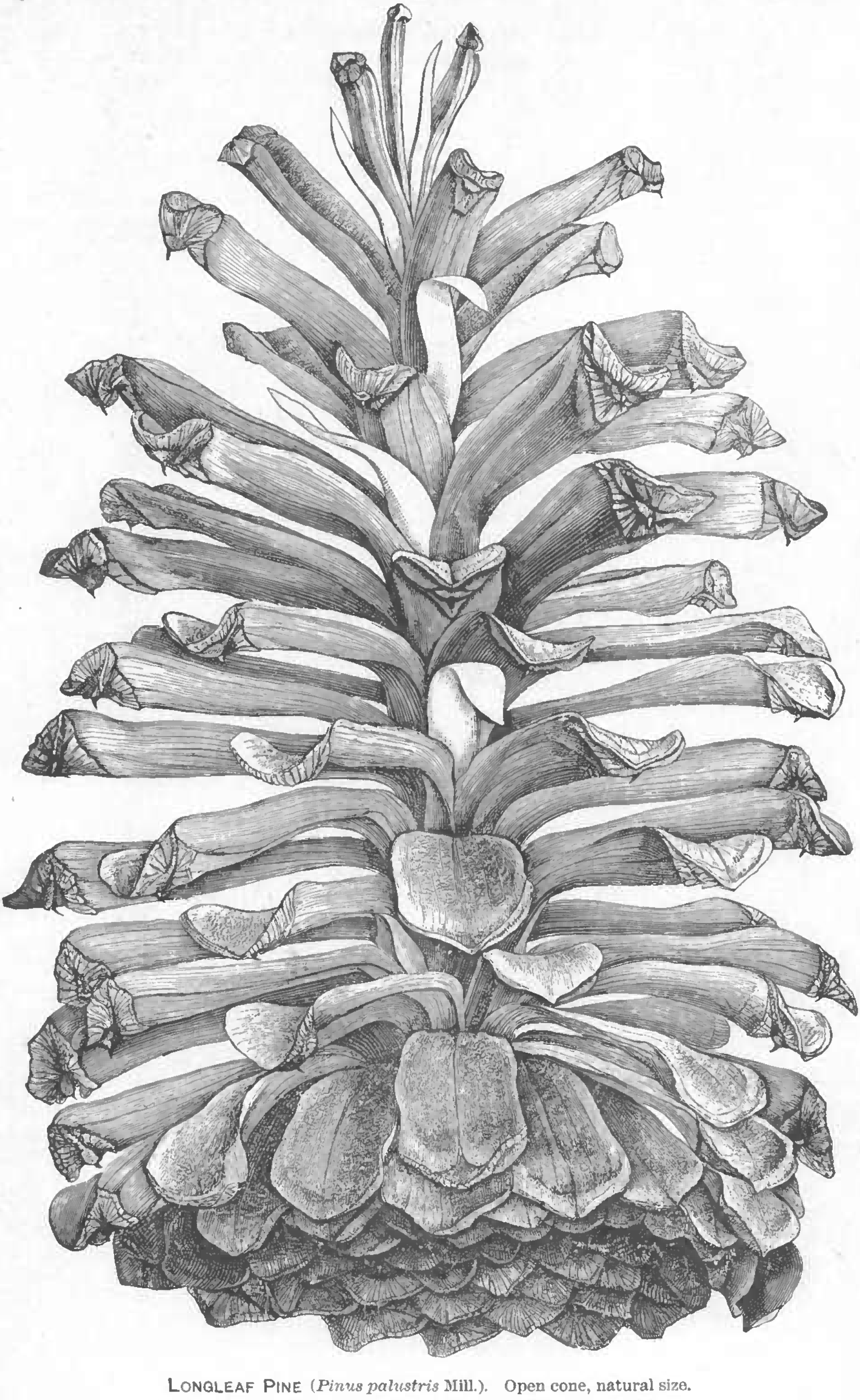
DISTRIBUTION AND HABITAT.

The geographical (botanical) distribution of the four important pines is shown in the accompanying maps. (These maps were prepared by Dr. Charles Mohr, of Mobile, Ala., agent of this division, and much of the information here given is taken from his still unpublished monographs on these pines.

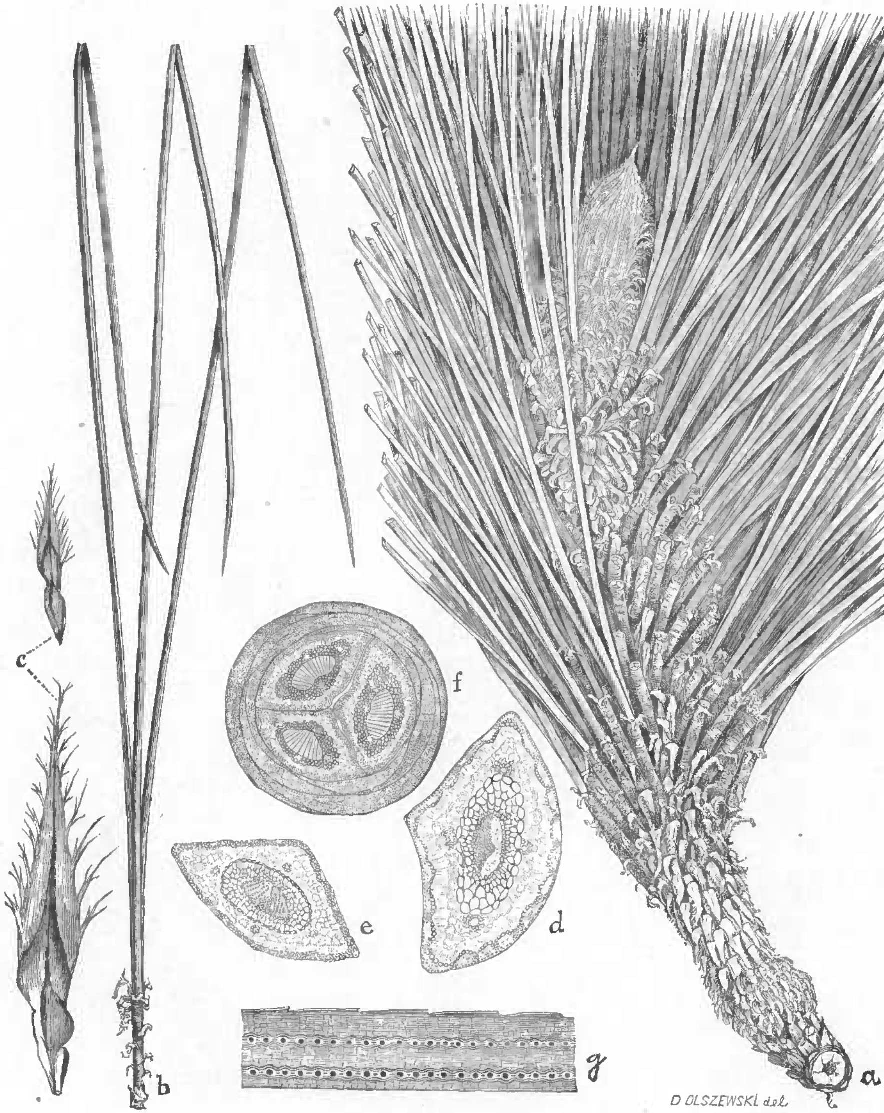
It is to be understood that not all the land within the boundaries indicated in the maps has been or is now covered by pine growth, but simply that within the lines the pines are found growing naturally. Nor is it to be understood that the areas which are indicated as producing a certain cut per acre do not contain places on which much more or much less lumber could be cut than the average figures given. These represent only a very general average for the region, based on conservative estimates, made for the purpose of showing more clearly the distribution in masses through the entire field of botanical distribution.

These approximations do not pretend to serve as guides to the purchaser of timber lands further than to indicate in what regions he is likely to find the pine sought for in greatest abundance and best development. A lumber dealer may also learn at one glance that he can not possibly be supplied with longleaf pine from a mill in Arkansas, nor with shortleaf pine from a mill on the Gulf coast, unless it be supplied with logs from inland.

Within the boundaries of geographical distribution each species is found to occupy certain soils and sites which form its habitat. The habitat of the pines in general is found on sandy and mostly well-drained soils. In regard to moisture conditions of the soil, the different species adjust themselves differently. The longleaf pine is found (only exceptionally otherwise) on the best-drained, deep, sandy, siliceous alluvium, while the Cuban pine is confined to the moister flats or pine

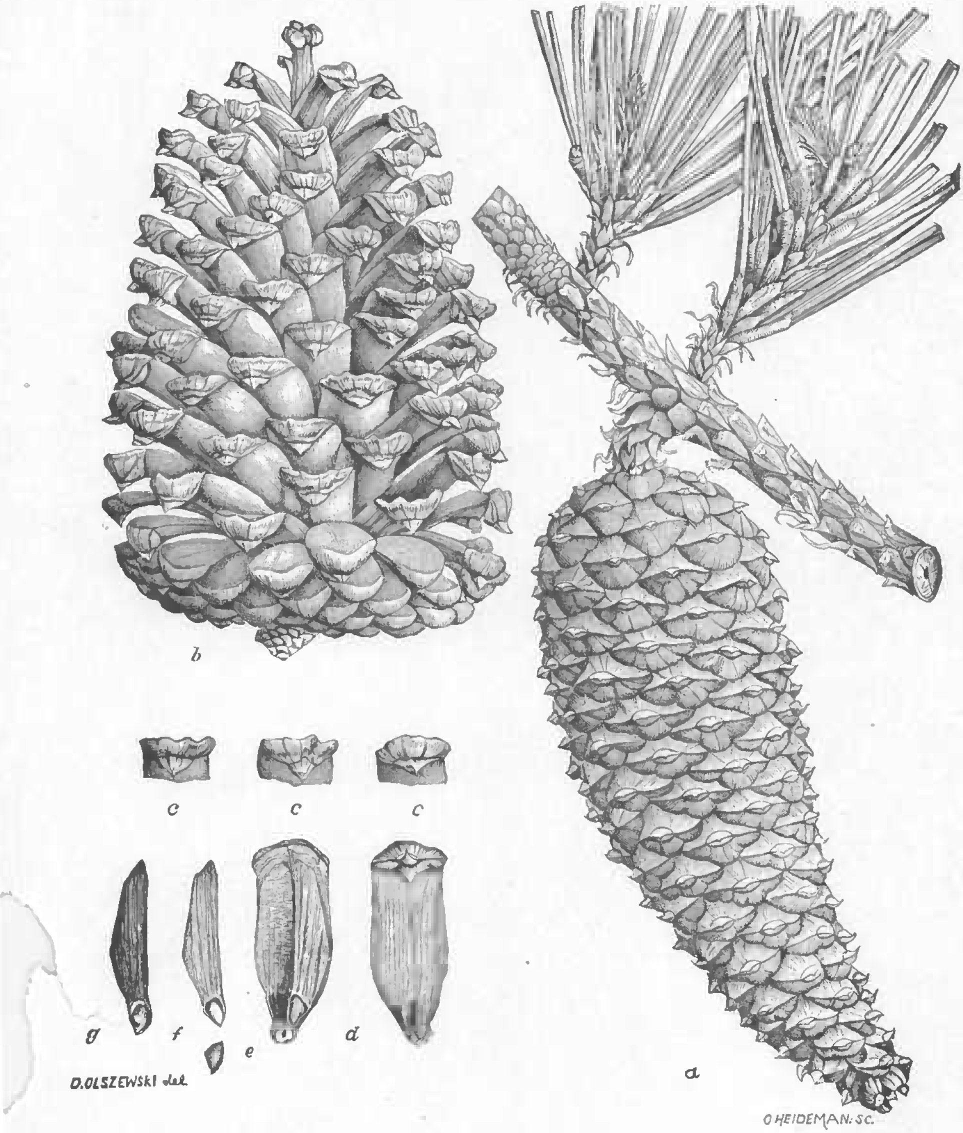


LONGLEAF PINE (*Pinus palustris* Mill.). Open cone, natural size.



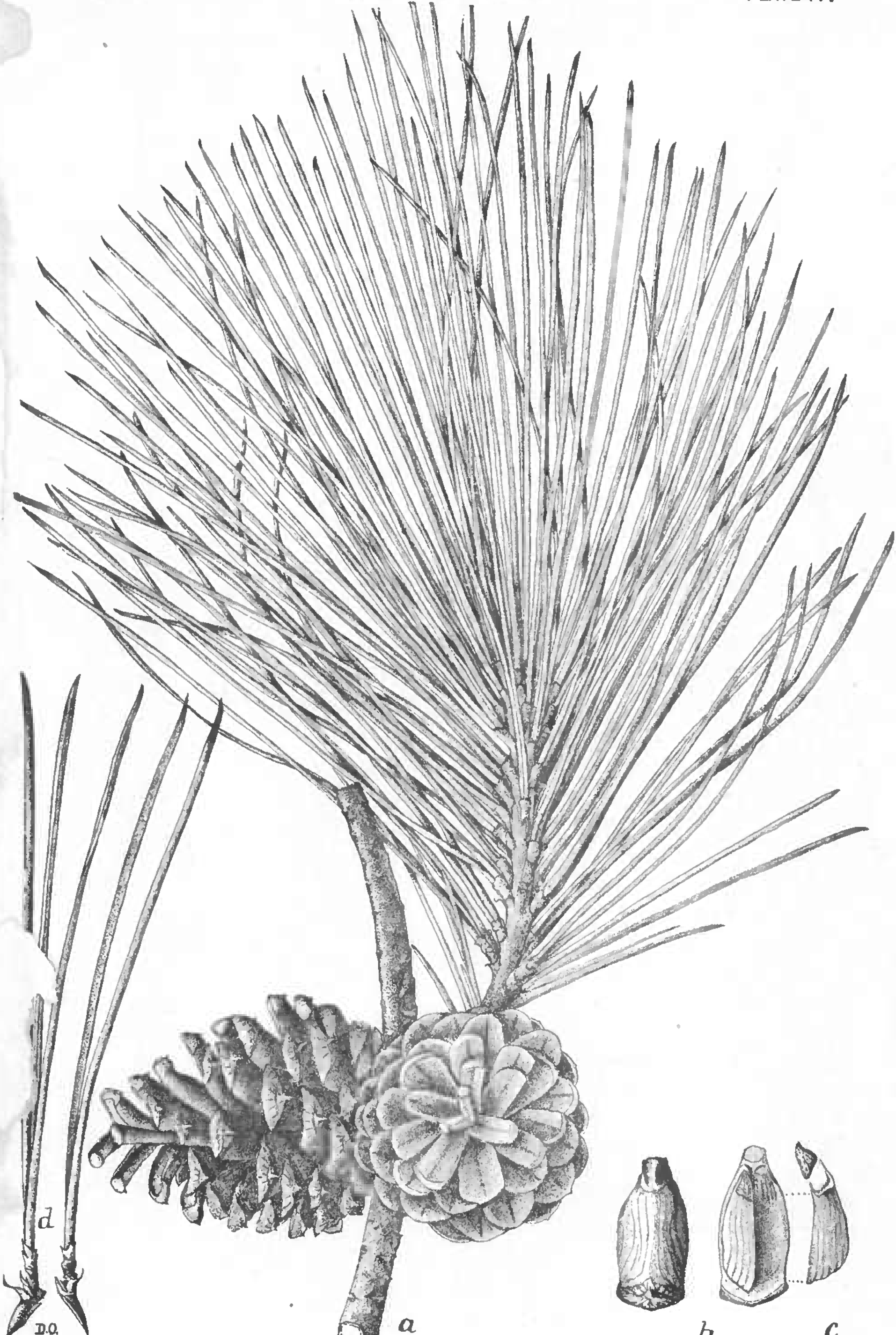
LONGLEAF PINE (*Pinus palustris* Mill.). Two-thirds natural size.

a, branch with terminal bud; *b*, leaf bundle; *c*, primary leaf bracts (magnified); *d*, *e*, *f*, cross sections (magnified) of leaves; *g*, epidermis of leaf (magnified).



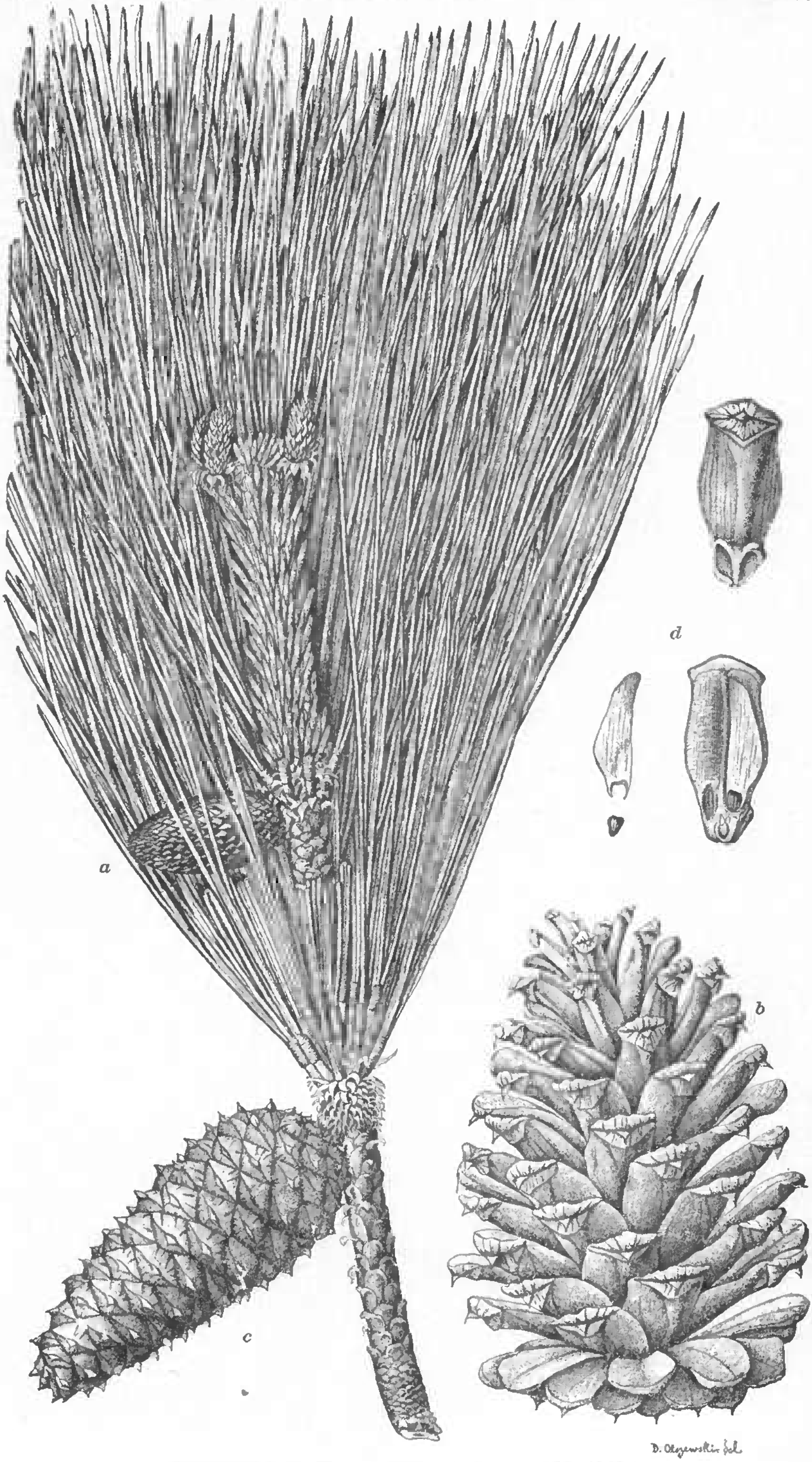
CUBAN PINE (*Pinus Cubensis* Griseb.). Two-thirds natural size.

a, closed cone; *b*, open cone; *c*, apophyses; *d*, cone scales, dorsal and ventral view; *e*, *f*, *g*, seed and seed wings, dorsal and ventral view.



SHORTLEAF PINE (*Pinus echinata* Mill.). Natural size.

a, branch with open cones; *b*, cone scales, dorsal and ventral view; *c*, seed and seed wing; *d*, leaf bundles.



LOBLOLLY PINE (*Pinus Tæda* L.). Two-thirds natural size.

a, young cones; *b*, mature open cone; *c*, mature closed cone; *d*, detached cone scales (dorsal and ventral view), with seed and wing.

meadows of the coast, and will grow closely down to the sandy swamps; not objecting to clayey admixtures in the soil, but shunning the dry sandy pine hills. The shortleaf pine prefers a well-drained, light, sandy or gravelly clay soil, or warm light loam; while the loblolly, often struggling with the shortleaf for the possession of the soil, can adapt itself to wetter situations.

CHARACTERISTICS OF DISTRIBUTION IN DIFFERENT REGIONS.

LONGLEAF PINE.

This pine occurs in all the South Atlantic and Gulf States at some distance from the coast, covering a belt of about 125 miles in width, interrupted only by the alluvial plains of the Mississippi and Red rivers in Louisiana and Texas. In addition, there is found in western Georgia and Alabama an extension in islands or patches northward to latitude 34.5°.

Within this range, going from the shore inland, the following divisions can be made: First, the coast plain, from 10 to 30 miles from seashore, contains only scattered growth on the grassy flats—the higher levels on which this pine prevailed are now mostly occupied by loblolly and Cuban pine; second, the rolling pine lands or pine barrens proper, covered with alluvial sands, are occupied almost entirely by this tree in perfection; third, the region of mixed growth, where this pine occupies in the main only the drift-covered ridges and is associated with the loblolly and shortleaf pines. Here it attains a larger size, with more full-sized trees per acre.

In Virginia this pine is almost extinct, and replaced by loblolly. In North Carolina, through the agricultural district, this pine is mixed with loblolly and shortleaf and is of little importance down to the Neuse River. The forests exclusively of longleaf pine begin below Bogue Inlet, with a width of 95 to 125 miles inland, reaching down to the State line, covering about 6,500,000 acres; very largely tapped for turpentine.

In South Carolina the pine belt is about 150 miles wide; is mainly occupied by this pine, but on the hill lands is intermixed with the shortleaf; the southwestern plateau, with a porous sand soil, furnishes timber of excellent quality, much of which is still untouched.

In Georgia the flatwoods of the shore are mostly stripped of this pine; the vast interior plain of about 17,000 square miles is almost exclusively covered with this tree.

In Florida the belt of longleaf pine of the Atlantic coast may be traced as far south as St. Augustine, being thence southward largely replaced by the Cuban pine. On the Gulf side more important longleaf growth is found farther southward, until the savannas and everglades are reached, where again the Cuban pine replaces it. In western Florida large areas are pretty well exhausted. The Gulf coast pine belt, covering some 40,000 square miles to the Mississippi River basin, shows no difference from the Atlantic forest.

The upper division of the pine belt or region of mixed growth in Alabama on a broken surface covers about 23,000 square miles, while the belt of drift deposit which crosses the State contains about 1,000 square miles, covered with longleaf pine of excellent quality and large yield per acre. The drift deposits along the Coosa River, covering about 300,000 acres, and a detached portion of drift in Walker County of 60,000 acres, are covered with pine of fine quality hardly yet touched.

Toward the west, in Louisiana, the coast pine belt gradually passes

into a mixed growth of shortleaf pine, oaks, and hickories on the uplands bordering the Mississippi. The slightly undulating flatwoods of Louisiana support a better timber growth than is generally found in the upland pine barrens; but this forest has been largely invaded, while the pine-hill region of Louisiana has remained almost untouched. The pine region west of the Mississippi River, limited to the sands and gravels of the region, follows on their eastern boundary the valley of the Ouachita River for 150 miles.

In the center of the region above the Red River pine ridges alternate with tracts of oak and hickory. Toward the Red River the forests covering the undulating pine lands remain practically unbroken to the Sabine River. On the eastern side of the Red River the area is estimated at 1,625,000 acres, extending northward an average distance of 55 miles, cutting from 4,000 to 6,000 feet per acre, with no change in character to the Trinity River in Texas. In that State the forests of longleaf pine cover about 5,000 square miles, merging toward the north into the region of shortleaf, toward the south into vast forests of loblolly-pine.

The fact that but little tapping for turpentine has been practiced in this region may be of importance from a market point of view.

CUBAN PINE.

This tree, which occurs mainly in the West Indies and South America, is confined within narrow limits in the United States, occupying the low coast plain of the Gulf States west of the Mississippi to a short distance beyond Pearl River, and of the Atlantic coast as far north as lower South Carolina, near Charleston. It is rarely found more than 40 or 50 miles inland, on the so-called pine flats or pine meadows. Only in southern Florida does it cross from Gulf to Ocean on the low ridges through the everglades. It occurs either scattered through other forest growth of the swamps or in groves along the borders of sandy swamps above perpetual overflow, mixed with longleaf or, more rarely, loblolly-pine, excepting south of Cape Canaveral and Biscayne Bay, where it forms open forests by itself. Being able to thrive on pure sand as well as on the clay soils with poorer drainage, it is apt to crowd out the young growth of longleaf pine when the old trees of the latter have been cut. It is indiscriminately cut and made into lumber together with the longleaf pine without distinction. Its field of distribution is indicated on the map of the longleaf pine by patched area.

SHORTLEAF PINE.

This tree is more widely distributed than any of the other pines, namely, from the southern shores of Connecticut, where it occurs only scattered, to the treeless plains of Kansas and southward in the main to the northern line of the main body of the longleaf forests. It is mostly associated with deciduous-leaved trees, becoming the predominant forest growth in parts of northern Alabama, Mississippi, and western Louisiana. In northeastern Texas and southern Arkansas it covers large areas, to the exclusion of almost every other tree. While in the early history of this country this pine seems to have been a staple along the Atlantic coast up to New York, it occurs now only scattered and in commercially unimportant quantities north of Virginia. From here southward it covers large areas, occupying the higher inland parts of the maritime pine belt, mixed with other coniferous and deciduous growth, and throughout the interior of the Southern States into the mountainous region.

In North Carolina it is found from the coast to the mountains, and

once formed about 25 per cent of the forest growth, now largely reduced. In South Carolina and Georgia it is similarly mixed in the upland forests of oak and hickory.

In Florida it is confined along the northern border of the State to a narrow strip of uplands, with a mixed growth of longleaf and hardwood timber; in western Florida, where it is more rare, approaching the Gulf within 25 miles.

In Alabama and Mississippi it forms the larger part of the interior upland forests, in some sections becoming the prevailing tree, especially in the Warrior coal-fields and in the northern part of the central drift belt to northeastern Mississippi, while it is more sparsley scattered through the growth of the upper coast pine belt.

But its best development evidently lies west of the Mississippi, occurring in greatest abundance and perfection in northeastern Texas, northwestern Louisiana, and southern Arkansas. In Texas, east of the Trinity River, it forms dense forests almost entirely by itself.

North of the Arkansas River, it is found in smaller or larger areas, scattered through the upland regions to central Missouri. It is the pine of the Indian Territory, where large bodies occur, and of southwestern Missouri, and occurs also in Kansas as far north as the Osage River.

It is less frequent in Kentucky and Tennessee, being more confined to the eastern portions of those States. Only a single station is reported from southern Illinois, and its occurrence in the other parts of the field of distribution is mainly of botanical interest.

Since this tree occurs mainly in mixtures of different degree with other timbers, it is impossible to state yield per acre in general. In its western range, where it predominates, a cut of 3,500 to 4,000 feet, board measure, per acre may be assumed. On the Atlantic coast supplies are largely reduced.

A rough guess places the possible standing timber of this species at 160,000,000,000 feet, board measure.

LOBLOLLY-PINE.

This pine is found in all the Southern States excepting Kentucky and Missouri, with its northernmost limit on the banks of the Rappahannock, below Washington, D. C. On the Atlantic slope it occupies the flat lands of the tide-water districts, either mixed with other species or forming compact bodies of timber. In Virginia it forms about 75 per cent of the timber standing east of the Richmond-Petersburg line, rapidly taking possession of abandoned fields. In North Carolina it associates with the longleaf pine, and is especially well developed in the low rich soil of the swamp borders, but here largely exhausted. Farther south in the pine barrens the longleaf pine prevails, and the loblolly is found only on the low borders of swamps and streams. In the Carolinas and Georgia it is also found inland to the foot of the mountains. In Florida it is rare, except in the northern part, being replaced southward by the Florida old-field pine (*P. clausa*).

About one-half of the pine timber on the flat, badly drained tablelands of the Warrior coal-field in north Alabama consists of this pine, forming compact bodies of heavy timber or associated with hardwoods. It abounds in Louisiana and southern Texas, in the flatwoods bordering the coast marshes, and in the latter State an area of fully 6,800 square miles, south of the shortleaf pine uplands and west of the longleaf area, is covered by an almost continuous forest of the loblolly, of excellent growth, yielding from 4,500 to 5,000 feet per acre.

CHARACTERISTICS OF THE WOOD.

No more difficult task could be set than to describe on paper the wood of these pines, or to give the distinctive features so that the kinds can be distinguished and recognized by the uninitiated. Only the combined simultaneous impressions upon all the senses permit the expert to make sure of distinguishing these woods, without being able to analyze in detail the characters by which he so distinguishes them. While in many cases there would be no hesitation in referring a given stick to one or the other species, others may be found in which the resemblance to more than one species is so close as to make them hardly distinguishable. The following attempt to diagnose these woods must, therefore, be taken only as an imperfect general guide. So far even microscopic examination has not furnished unfailing signs: Color is so variable that it can hardly serve as a distinguishing feature, The direction of the cut, roughness of surface, exudation of resin, condition of health, width of grain, moisture condition, even the mode of drying, exposure, etc., all have their share in giving color to the wood. Bearing in mind this great complication of color effects, it will be granted that descriptions of the same, disturbed by peculiarities of each separate observer, will aid but little in identifying the woods.

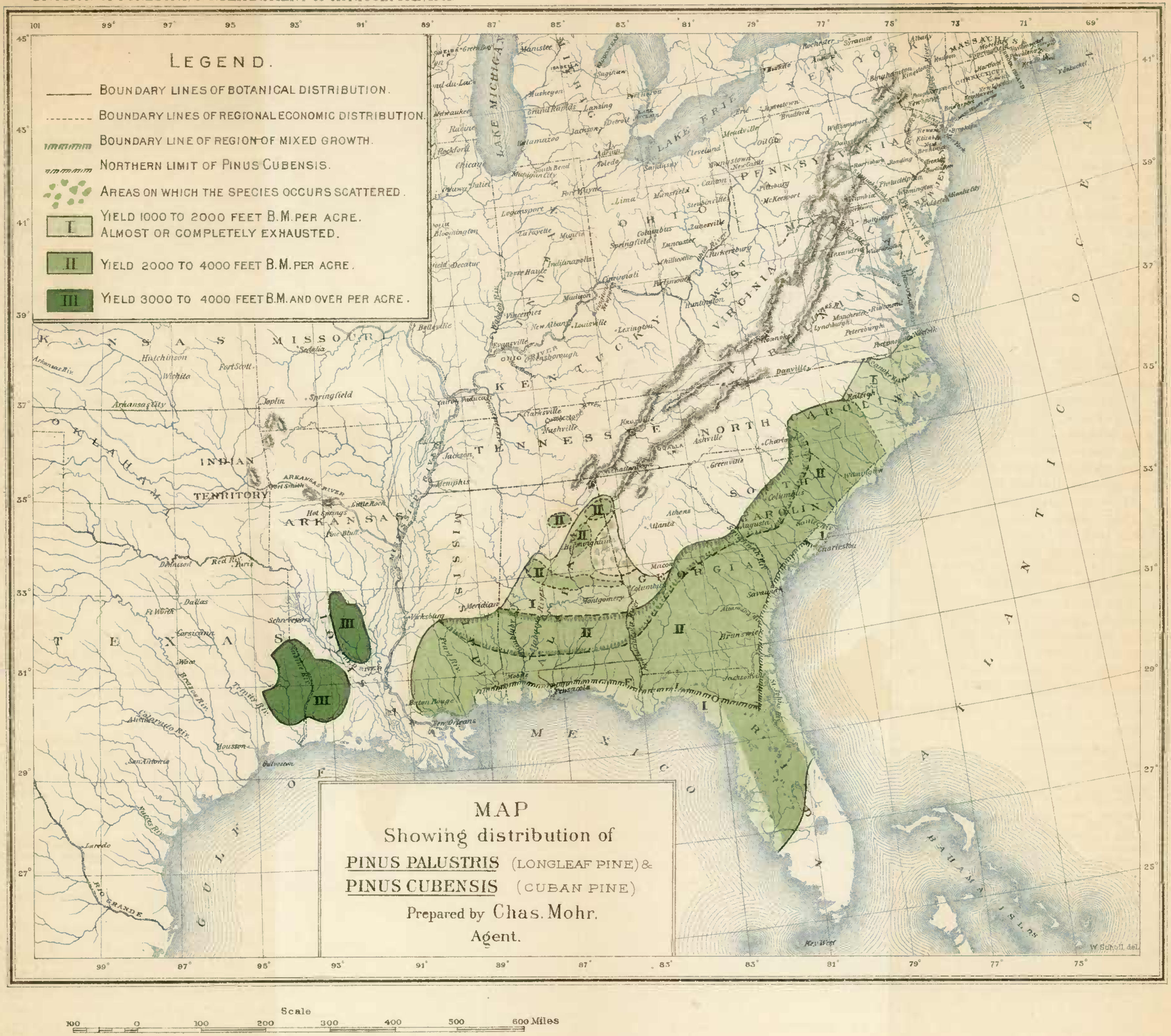
The sapwood of all the pines looks very nearly alike, and so does the heartwood. The color of the spring wood in the sap is a light yellowish with a shade of brown; the summer wood contains more brown, variable with the density of the cells and appearing darker when the bands are more abruptly separated from the spring wood. The heartwood shows a markedly darker color with a reddish flesh-color tinge added.

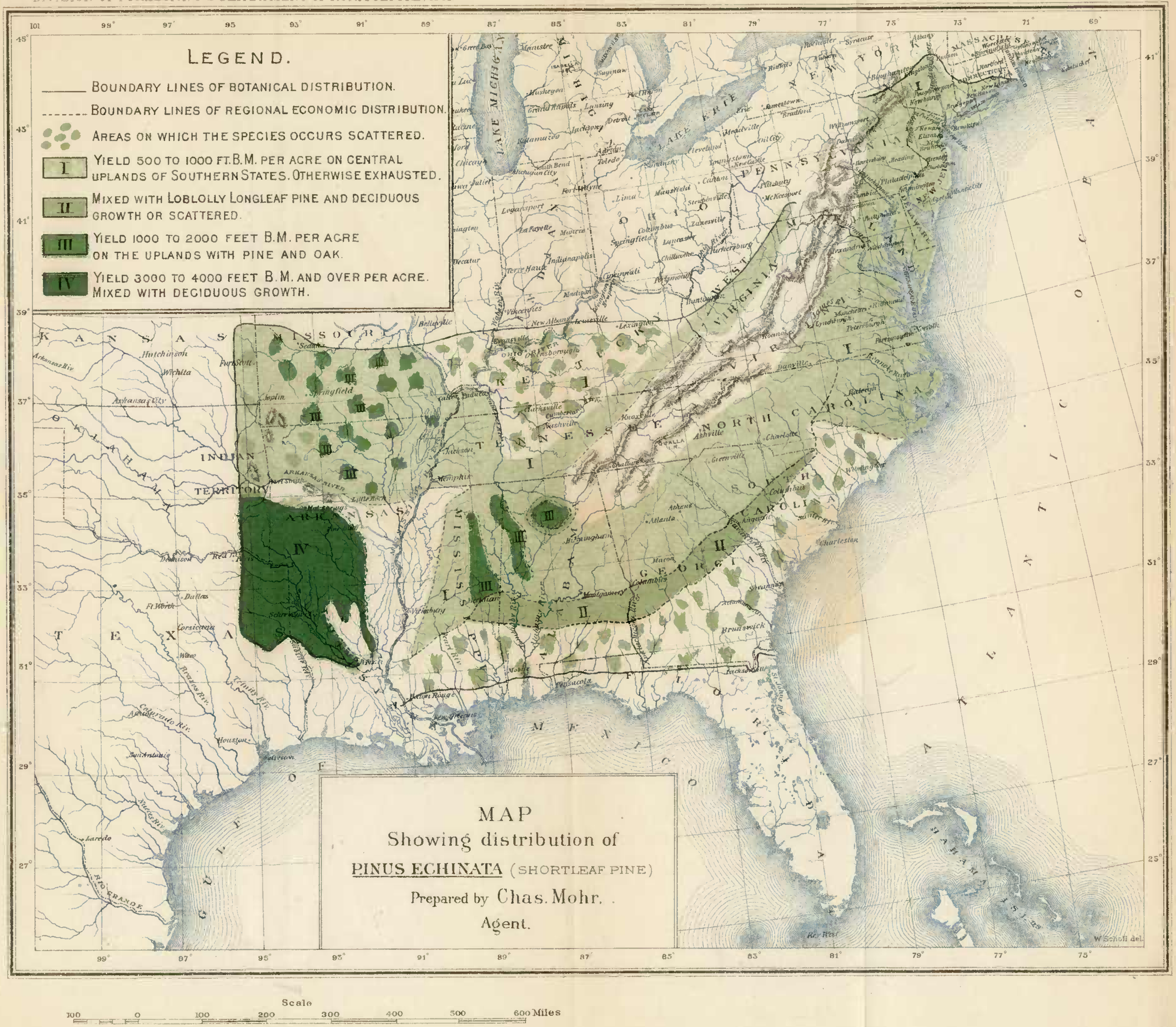
It is perhaps easiest to distinguish the wood of the longleaf and Cuban pines from that of the shortleaf and loblolly. It is also possible to keep apart the longleaf from the Cuban; but while, in general, the shortleaf and loblolly can be more or less easily distinguished by color or grain, some forms of the latter (rosemary-pine) so nearly resemble the former that no distinguishing feature is apparent.

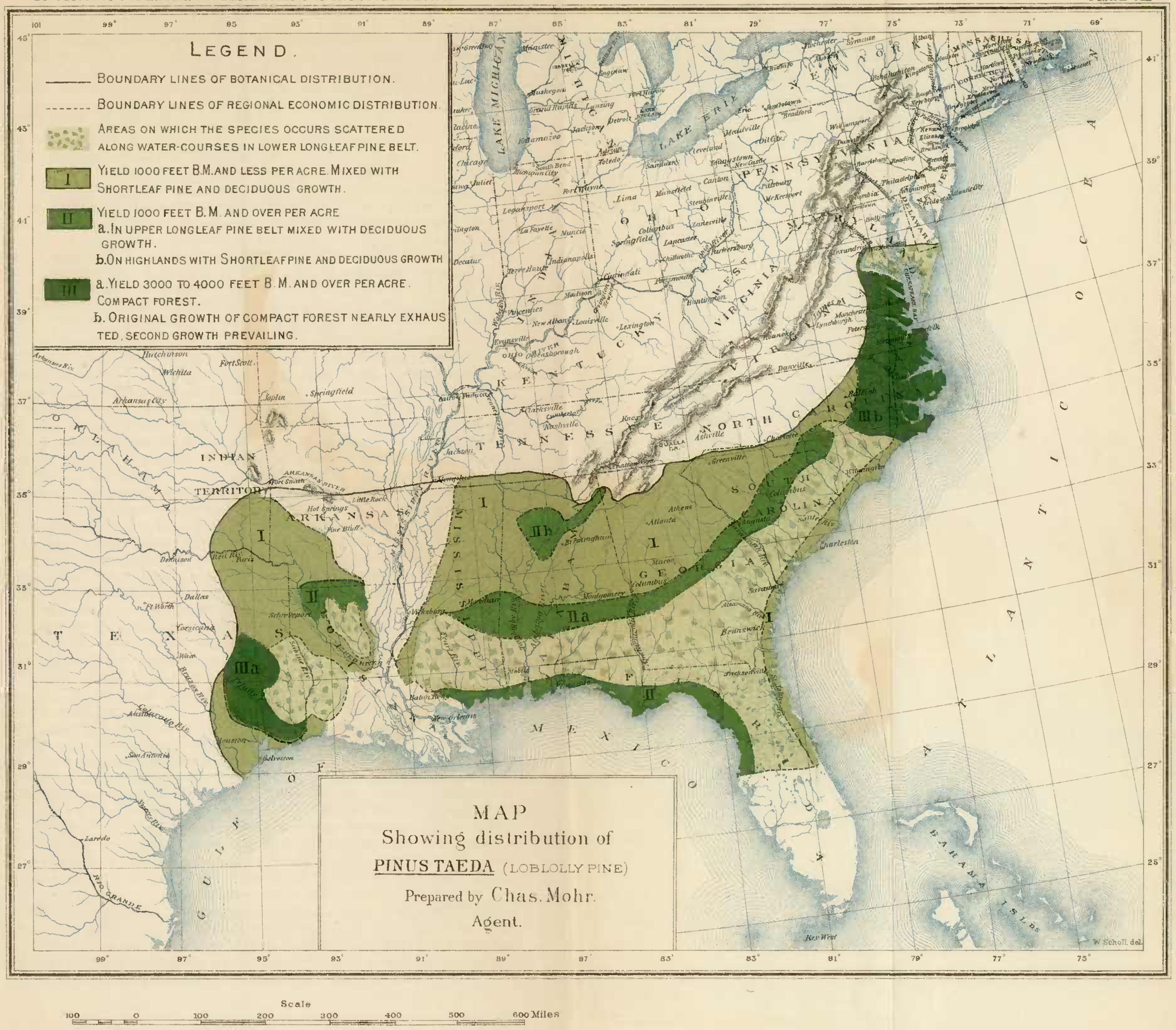
The most ready means for distinguishing the four seems to be the specific gravity or weight in connection with the grain. The proportion of sap and heart-wood will also be an aid in recognizing a log or log-run lumber in the pile. These distinctive features are tabulated as follows, the figures representing average conditions of merchantable timber and mature trees:

Diagnostic features of the wood.

Name of species.		Longleaf pine (*Pinus palustris* Miller).	Cuban pine (*Pinus cubensis* Griseb.).
Specific gravity of kiln-dried wood.	Possible range	.58 to .90	.65 to .84 (Sarg.)
	Most frequent range.	.60 to .70	
Weight, pounds per cubic foot, kiln-dried wood.	Possible range	44 to 52	38 to 50
	Average	48	47
Character of grain seen in cross section.		Fine and even; annual rings uniformly narrow throughout; not less than 8 (mostly about 25) rings to the inch.	Variable and coarse, rings mostly wide; from 6 to 8 rings to the inch.
Color, general appearance		Even dark reddish-yellow to reddish-brown.	Dark straw-color with tinge of flesh color.
Sapwood, proportion		Very little; rarely over 2 to 3 inches of radius.	Nearly one-half of the radius.
Resin		Very abundant; tree turning into "light wood;" pitchy throughout.	Abundant, sometimes yielding more pitch than longleaf; not turning into "light wood."


LEGEND.
BOUNDARY LINES OF BOTANICAL DISTRIBUTION.
BOUNDARY LINES OF REGIONAL ECONOMIC DISTRIBUTION.
BOUNDARY LINE OF REGION OF MIXED GROWTH.
NORTHERN LIMIT OF PINUS CUBENSIS.
AREAS ON WHICH THE SPECIES OCCURS SCATTERED.
I YIELD 1000 TO 2000 FEET B.M. PER ACRE. ALMOST OR COMPLETELY EXHAUSTED.
II YIELD 2000 TO 4000 FEET B.M. PER ACRE.
III YIELD 3000 TO 4000 FEET B.M. AND OVER PER ACRE.
MAP
Showing distribution of
PINUS PALUSTRIS (LONGLEAF PINE) &
PINUS CUBENSIS (CUBAN PINE)
Prepared by Chas. Mohr.
Agent.
W. Suholl del.
Scale
100 0 100 200 300 400 500 600 Miles


LEGEND.
BOUNDARY LINES OF BOTANICAL DISTRIBUTION.
BOUNDARY LINES OF REGIONAL ECONOMIC DISTRIBUTION.
AREAS ON WHICH THE SPECIES OCCURS SCATTERED.
I YIELD 500 TO 1000 FT. B.M. PER ACRE ON CENTRAL UPLANDS OF SOUTHERN STATES. OTHERWISE EXHAUSTED.
II MIXED WITH LOBLOLLY LONGLEAF PINE AND DECIDUOUS GROWTH OR SCATTERED.
III YIELD 1000 TO 2000 FEET B.M. PER ACRE ON THE UPLANDS WITH PINE AND OAK.
IV YIELD 3000 TO 4000 FEET B.M. AND OVER PER ACRE. MIXED WITH DECIDUOUS GROWTH.
MAP
Showing distribution of
PINUS ECHINATA (SHORTLEAF PINE)
Prepared by Chas. Mohr.
Agent.
W Schütt del.
Scale
100 0 100 200 300 400 500 600 Miles


LEGEND.
BOUNDARY LINES OF BOTANICAL DISTRIBUTION.
BOUNDARY LINES OF REGIONAL ECONOMIC DISTRIBUTION.
AREAS ON WHICH THE SPECIES OCCURS SCATTERED ALONG WATER-COURSES IN LOWER LONGLEAF PINE BELT.
I YIELD 1000 FEET B.M. AND LESS PER ACRE. MIXED WITH SHORTLEAF PINE AND DECIDUOUS GROWTH.
II YIELD 1000 FEET B.M. AND OVER PER ACRE
a. IN UPPER LONGLEAF PINE BELT MIXED WITH DECIDUOUS GROWTH.
b. ON HIGHLANDS WITH SHORTLEAF PINE AND DECIDUOUS GROWTH
III a. YIELD 3000 TO 4000 FEET B.M. AND OVER PER ACRE. COMPACT FOREST.
b. ORIGINAL GROWTH OF COMPACT FOREST NEARLY EXHAUSTED, SECOND GROWTH PREVAILING.
MAP
Showing distribution of
PINUS TAEDA (LOBLOLLY PINE)
Prepared by Chas. Mohr.
Agent.
W. Scholl, del.
Scale
100 0 100 200 300 400 500 600 Miles

Diagnostic features of the wood—Continued.

Name of species.		Shortleaf pine (*Pinus echinata* Miller).	Loblolly-pine (*Pinus Tæda* Linn.).
Specific gravity of kiln-dried wood.	Possible range.	.39 to .76	.38 to .61
	Most frequent range.	.50 to .66	.43 to .48
Weight, pounds per cubic foot, kiln-dried wood.	Possible range.	36 to 44	31 to 36
	Average	40	34
Character of grain seen in cross section.		Very variable; medium, coarse; rings wide near heart, followed by zone of narrow rings; not less than 4 (mostly about 10) rings to the inch.	Less variable, mostly very coarse; 3 to 12 rings to the inch, generally wider than in shortleaf.
Color, general appearance		Yellowish-red	Whitish to brownish-yellow; the dark bands of summer wood being proportionately narrow.
Sapwood, proportion		Commonly over 4 inches of radius.	Very variable, $\frac{1}{3}$ to $\frac{1}{2}$ of the radius.
Resin		Moderately abundant, least pitchy; only near stumps, knots, and limbs.	Abundant; more than shortleaf, less than longleaf and Cuban.

QUALITY AND ADAPTATION OF WOODS.

Until the exhaustive research described in another part of this report has progressed further, these two questions can be only partially answered from past experiences.

The longleaf pine is superior wherever strength and durability are required. In tensile strength it approaches, and may surpass, cast iron. In crossbreaking strength it rivals the oaks, requiring 10,000 pounds per square inch on the average to break it, while in stiffness it is superior to the oak by from 50 to 100 per cent. It is best adapted for principal members of heavy construction, for naval architecture, for bridges, trestles, viaducts, and house-building. The finer-grained and especially the curly timber is much sought for finishing-wood. Its hardness fits it for planks and flooring, but unless quarter-sawed it is apt to "peel out." Being very resinous, it is sometimes difficult to handle in dry-kilns, nor does it take paint readily; its hardness also makes it difficult to work, wearing out tools and muscles. The curly-grained lumber, which is found quite frequently, makes an elegant finishing and furniture wood. It is an excellent fuel, and its resinous products supply the world with pitch, resin, and turpentine. Contrary to common belief, the tapping for turpentine was found by a large number of tests, lately made under direction of this division, not to weaken, but to strengthen the timber in crossbreaking and compression and to increase its stiffness.

The Cuban pine, mostly known locally as slash-pine, is generally cut and sold without distinction from the longleaf, and its wood, if not superior in some respects, is probably not inferior in any to the latter, except as far as its coarser grain and larger amount of sapwood may influence its usefulness. The tests of the Tenth Census would make its mechanical properties even superior to those of the longleaf.

The shortleaf pine, comparatively free from resinous matter, softer, capable of good finish, and more easily worked, furnishes a lumber better adapted to the use of the joiner, cabinet-maker, and carpenter than the other two. There being more sapwood in the log-run lumber and greater variation in its growth, more need for grading exists.

Until within a decade or so this lumber did not find ready market outside of its home, because the sapwood was apt to "blue," but with the dry-kiln these objections have been overcome and it now finds wide application for lighter framework, weatherboarding (taking paint more

readily than the longleaf pine), for flooring, ceiling, wainscoting, window casings, and sash and doors, and for shingles. It is also adapted for building of railroad cars and manufacture of furniture. In cross-breaking strength it is at least 25 per cent weaker than the longleaf, although occasional sticks are found as strong. In stiffness the difference is not so great on the average, but the best stick so far tested falls 20 per cent below the best longleaf. In shearing strength, however, it seems to equal the latter, showing that, although weaker, its cell elements are as firmly knit together.

The loblolly-pine varies still more greatly in quality than the shortleaf pine, growing as it does under the most varied conditions. Hence opinions as to its value vary widely, and its usefulness is but imperfectly understood except perhaps in some parts of its home, like lower Virginia, where most of the houses were built of this pine. Grown slowly on the poorer or wetter soils, at higher elevations and in more northern climate, it produces more heartwood and better quality, while the rank growth on better soils presents a sappy, light, coarse-grained wood, soft, and quick to decay. In North Carolina, where it occupies the swamp borders, the variety, or rather the "quality," known as "rosemary" or "slash" pine, now nearly exhausted, furnishes a timber from long and large old trees in no way inferior to the shortleaf, which it closely resembles, and approaching even the longleaf.

Strength and durability it does not possess in great measure, but, properly seasoned, it furnishes a timber suitable for many purposes. Yet the timber tested from north Alabama seems to equal, if not surpass, in strength and stiffness the shortleaf from the same region. It is perfectly suited for rough work, joists and scantling, studding, and common boards, and about 75 per cent of the material for this purpose used in the markets of Baltimore and Washington comes from this pine, and the bulk is sawed in Caroline County, Va. Much is also used in Philadelphia. The best grades are selected for flooring, siding, and inside finish, although its liability to shrink, unless thoroughly seasoned, makes the propriety of this use doubtful. As cordwood it reaches also more northern markets (New York), and where a brisk flame with quick heat is desired, as in bakeries, brickyards, and potteries, it is very good. The name under which this lumber goes is Virginia pine, although I have found builders calling it "yellow pine" and "North Carolina" pine. Since this pine is of rapid growth, quickly occupying old abandoned fields and making sawlogs in fifty years, it promises to become one of the prominent staples of our lumber market.

In North Carolina only the better quality is cut and sold indiscriminately with the shortleaf as "North Carolina" pine, while in the Gulf States east of the Mississippi but little is cut, and that only on special orders for inferior work (except in north Alabama). In Texas, however, where this pine abounds in perfection, 25 and more per cent of the lumber handled is loblolly, although at Beaumont, the principal point of lumber production, but little of this material was found at the mills. In Arkansas it is called "longleaf pine," and some Northern lumber yards which must have longleaf pine from Arkansas seem to supply themselves with this material. It is tapped for turpentine wherever found in the turpentine orchard, yielding a more fluid resin than the longleaf pine.

DISCUSSION OF COMMON NAMES.

The common names used for these pines, a full list of which appears on pages 212, 213 of this report, may be divided into two classes, namely,

those used by manufacturers and in the market, and those used locally by loggers and lumbermen or country people.

MARKET NAMES.

The various names under which Southern pine lumber appears in the market are either general or specific; the former being more or less general in application to lumber manufactured in the South, without reference to special localities, the latter referring to special localities from which the lumber is actually or presumably derived. In regard to the latter class of names it is to be regretted, perhaps, that they have been found necessary, the more because through their use not a few misconceptions and difficulties have arisen between consumers, manufacturers, and wholesale dealers, owing to the difficulty in defining what tree species furnish lumber included by such name or names. The uninitiated may not understand that the various kinds of pine lumber manufactured in different States, although called by a specific name, may, after all, be of the same species and the same in all respects. "Florida long-leaved yellow pine" or "Florida pine," is in no way different from that cut and manufactured in Georgia under the distinctive name of "Georgia long-leaved yellow pine," or "Georgia pine." The question as to any difference of quality dependent upon locality of growth is as yet undecided.

The market names given to the various pines, uncertain as to their precise application in the minds of those that use them, or at least at variance with the conception of other authorities, are the following:

General—Yellow pine, Southern yellow pine, Southern pine, long-leaved yellow pine, long-leaved pine, hard pine, pitch-pine.

Specific—Virginia yellow pine, Virginia pine, North Carolina yellow pine, North Carolina pine, Georgia yellow pine, Georgia pitch-pine, Georgia pine, Georgia longleaf yellow, Georgia long-leaved pine, Florida yellow pine, Florida pine, Florida long-leaved pine, Texas yellow pine, Texas long-leaved pine.

The names "yellow pine," "Southern pine," seem first of all to be used as generic names, without distinction as to species. In the quotations from Western markets only "yellow pine" and "long-leaved yellow pine," or "long-leaved pine" are distinguished; the first name seemingly being now always used when "shortleaf" is meant, although it is also applied by advertisers from the longleaf-pine region to their product. In a market report of a leading lumber journal we find that "in the yellow pine line, longleaf, shortleaf, and curly pine can be bought," which would show that the attempt to distinguish the two kinds by their proper names is made. Curly pine, however, is in most cases longleaf pine with a wavy or curly grain, a sport, which is also found in the shortleaf species. Loblolly seems not to be quoted in the Western markets.

Formerly, while the longleaf pine was the only pine reaching the markets, it was commonly known under the name of "yellow pine," but now the supply under this name may be made up of all the species indiscriminately. In Texas and Louisiana "yellow pine" designates the longleaf species, in Arkansas and Missouri the shortleaf, while there the name "longleaf" is applied to the "loblolly," which is rarely cut.

In Florida, the Carolinas, and Georgia the name "yellow pine" is also used with less distinctive application. In Florida, besides the Cuban pine, which is never distinguished on the market, loblolly may also appear in the lumber pile. In Georgia and the Carolinas, although locally the name "yellow pine" is most frequently applied to the short-

leaf, in the market a mixture of longleaf, shortleaf, loblolly, and Cuban pine satisfies the name.

In England, where probably nothing but longleaf pine is handled, the current name is "pitch-pine," and this name is also most commonly used in Georgia and North and South Carolina, strictly applying to longleaf pine. In Boston only Southern and hard pine is mentioned without distinction. It is in New York, Philadelphia, Baltimore, and other Atlantic markets that the greatest variety of names is used, with an attempt to distinguish two kinds, the longleaf and shortleaf, by using the name of the State from which the lumber is supposed to come, but neither the name nor the lumber pile agree always with the species that was to be represented.

"North Carolina pine," which is supposed to apply specifically to shortleaf, will be found to include in the pile also better qualities of loblolly, sometimes to the amount of 50 per cent. Longleaf forms only very occasionally a part of the supplies from this section.

"Georgia pine" is meant to designate the longleaf species, and, like "Florida pine," does mostly conform to this designation except as noted before under the name of yellow pine.

"Virginia pine" or "Virginia yellow pine" are names hardly known elsewhere than in the markets of Baltimore and Washington, where the bulk of the common building timber consists of it. It applies in the main to the loblolly, with a very small percentage of shortleaf making its way into the pile. While this is mostly coarse-grained inferior material, selected stuff, when well seasoned, furnishes good finishing and flooring material.

FIELD NAMES.

Field names are those applied to the four Southern pine lumber species in the tree and logs. Such names are usually more or less known to dealers and manufacturers, but, aside from the market names already discussed, are rarely if ever applied to lumber in the market.

Of the three pines, longleaf, shortleaf, and loblolly, the first alone is perfectly known by lumbermen and woodmen as a distinct "variety" (species). The remaining species, presenting to the lumberman's eye various forms according to the site producing the timber, are commonly supposed "varieties" or "crosses" more or less related to the longleaf pine. Specific differences in the lumber, both in appearance and quality form, however, a sufficient basis of distinction as far as lumber is concerned, although this distinction is not necessarily carried out in putting lumber on the market.

A few of the names in common use are frequently applied by lumbermen to entirely different species from those usually known to botanists by the same name. The perplexity thus arising, upon the supposition that the common names of our botanical text-books are applied to the species by lumbermen, is not inconsiderable, and can doubtless be avoided only by a more careful attention on the part of the people to real specific distinctions.

The confusion in names is such that it is almost impossible to analyze properly the use of these names in the various regions. In the tabulated account of names on pages 212, 213, a geographical distribution has been given, as far as possible. Here only a few of the names are to be discussed.

"Pitch-pine" is the name most commonly applied to the longleaf in the Atlantic regions, and where it occurs associated with the shortleaf and loblolly the former is called "yellow pine" and the latter is called "shortleaf." The name "longleaf or long-leaved pine" is rarely heard in the field, "longstraw" being substituted.

The greatest difference of names and consequent confusion exists in the case of the loblolly, due no doubt to the great variety of localities which it occupies and consequent variety of habit of growth and quality. "Swamp" and "sap-pine" refer to comparatively young growth of the loblolly, coarse-grained, recognized by the rather deep longitudinal ridges of the bark, growing on low ground. "Slash-pine" in Virginia and North Carolina is applied to old well-developed trees of both loblolly and shortleaf; in Florida it is exclusively applied to the Cuban pine. When applied to the loblolly it designates a tree of fine grain, one-half to two-thirds sap, recognized by the bark being broken into large, broad, smooth plates. This same form is also called "shortleaf pine" in North Carolina.

"Rosemary-pine" is a name peculiar to a growth of loblolly in the swamp region of the Carolinas, representing fully grown trees, fine grained, large amount of heart, and excellent quality, now nearly exhausted.

"Loblolly" or "old-field pine," as applied to *Pinus Tæda*, is a name given to the second growth springing up on old fields in the North and South Carolinas, while in Alabama and Mississippi, etc., the name "old-field" pine is applied to *Pinus echinata*.

UNIFORMITY OF NOMENCLATURE IN THE MARKET.

If it could be brought about by coöperation of sawmill men, lumber-dealers, architects, and engineers, a more uniform and distinctive nomenclature, at least in the markets and in specifications, would be most desirable.

The desirable names have been proposed in the table on pages 212, 213, namely, longleaf, Cuban, shortleaf, loblolly. To meet the practice of mixing the different kinds, which is certainly not desirable from the standpoint of the consumer, although it could often hardly be obviated, and to meet also the notion that different States produce different qualities, it would be possible in specifications to designate the kind from a given locality and to restrict the mixture to certain proportions of different kinds permissible. Much better, however, would be a description of quality as to grain and proportion of sap.

When the investigations described in another part of this report have advanced further, it will be possible to be more precise in these particulars and to specify with more knowledge and to inspect with more certainty as to the quality of the material.

FOREST RESERVATIONS AND THEIR MANAGEMENT.

The writer has every year in his reports pointed out the need of a change in the policy of the Government with regard to the public timber lands, under which large areas once heavily timbered have been turned into fire-swept barrens, and he has dwelt upon the incongruity of having a Division of Forestry in a Department of the Government to preach rational forest management, while such is entirely absent from the Government timber lands.

A change in this policy seemed at last to be contemplated by the enactment of a law dated March 3, 1891, in which the President is empowered to set aside forest lands for reserves; but unfortunately the same law opened up to almost unrestricted use all timber lands not so reserved.

In regard to this latter provision the language of the honorable Secretary of the Interior may be quoted:

The act makes it lawful, subject to the rules of the Secretary, to cut public timber in the States and Territories named for so many and such general purposes, that the only restraint imposed is that which the Secretary may see fit to enforce. No one could cut timber not to be described by some one of the words used, "agricultural, mining, manufacturing, or domestic," unless it were in mere wantonness. There is no limit as to the time when the timber or lumber made from it is to be so used, and it may easily be cut within the law and stored for sale, for it is not provided even that it shall be for use by the person cutting it.

The law itself gives every license for felling the forests, and even the amendment only authorizes restraint to be exercised by the Secretary of the Interior. Experience has shown that it is very difficult to preserve the public timber under laws providing direct penalties for trespasses, and it can not be doubted punishment will be much less certain for violations of Departmental regulations. Besides this, the statute imposes much more upon the executive officer than he should be required to assume. Already the applications for permits are so numerous as to have demanded a special force in the General Land Office to attend to them, and as people learn the value of these privileges the pressure for them will constantly increase, until, unless the law is repealed or modified, there will be little timber left to protect. The States indicated are not very abundantly supplied at best, and with the increased value of forest products it will take but a small percentage of their population to exhaust every possible claim. It would seem to be much better that the statute should be so made as itself to prevent this result than that so important a matter should be left to the Secretary. This officer changes with each administration, and, so long as there is anything to give, he will find it difficult to refuse to some that which has already been granted to others.

In view of this condition of things it is to be hoped that the broadest construction will be given to the section relating to reservations without delay, and that full use be made of the authority conferred therein. This authority is given unconditionally, and the objects are left unexplained by the law. There can hardly be any doubt, however, as to what objects and considerations should be kept in view in reserving such lands and withdrawing them from private occupancy. These are first and foremost of economic importance, not only for the present but more specially for the future prosperity of the people residing near such reservations, namely, first, to assure a continuous forest cover of the soil on mountain slopes and crests for the purpose of preserving or equalizing waterflow in the streams which are to serve for purposes of irrigation, and to prevent formation of torrents and soil washing; second, to assure a continuous supply of wood material from the timbered areas by cutting judiciously and with a view to reproduction. Secondary objects, such as can and will be subserved at the same time with those first cited, are those of an æsthetic nature, namely, to preserve natural scenery, remarkable objects of interest, and to secure places of retreat for those in quest of health, recreation, and pleasure. Both objects are legitimate, but the first class is infinitely more important, and the second is easily provided for in securing the first.

Since there have arisen misconceptions in regard to these propositions it may, perhaps, be proper to emphasize the fact that the multiplication of national parks in remote and picturesque regions was not the intent of the law, but it was specially designed to prevent the great annual conflagrations, to prevent useless destruction of public property, to provide benefit and revenue from the sale of forest products as needed for fuel and lumber by residents of the locality, and altogether to administer this valuable and much-endangered resource for present and future benefit. These, I take it, are the objects of the proposed reservations.

Forest management, such as contemplated, does not destroy natural

beauty, does not decrease but gives opportunity to increase the game, and tends to promote the greatest development of the country, giving regular and steady employment, furnishing continuous supplies, and making each acre do its full duty in whatever direction it can produce most.

The friends of the movement in behalf of a rational forest policy will be glad to learn that the President acted promptly in proclaiming a reserve on the White River Plateau, in Colorado, embracing the head waters of the White, Grand, and Yampa rivers, another at the head of Pecos River, in New Mexico, and also in enlarging the boundaries of the Yellowstone Park.

A petition of the American Forestry Association recommending for reservation the following tracts, information regarding which had been collected in this division, was promptly referred to the Secretary of the Interior, and agents to examine the locations were at once sent out by the General Land Office to investigate the propriety of such reservations in the localities mentioned.

These reservations may be briefly designated as follows:

(1) The Flathead and Marias River region, occupying the rugged and mountainous continental divide in northwestern Montana.

(2) The rugged slopes of Pike's Peak, in Colorado.

(3) The mountain region northeast of Santa Fé, N. Mex., at the head of the Pecos and the Canadian rivers.

(4) The Tulare region, comprising much of the western slope of the Sierra Nevada range in eastern and southern California.

(5) The Crater Lake region, in southeastern Oregon.

(6) The Turtle Mountain region, in Bottineau and Rolette counties, N. Dak.

(7) The Lost Park region, in Colorado.

(8) The unoccupied lands about the head waters of the Mississippi River in northern Minnesota.

As was strongly urged in the memorial of the American Forestry Association to the President, neither of the objects for which this withdrawal of timber lands from entry and indiscriminate use is recommended will be attained by reservation unless followed by proper management.

Excepting on the western slopes of the Pacific mountain ranges, the climate of the largest part of the territory concerned is such as to render forest management for reproduction and reforestation difficult. This difficulty has been increased by the action of man in baring slopes and burning the fertile leaf mold, thus reducing the chances of germinating seeds and young seedlings. Difficulties of this nature can only be removed after careful study and experiment in the field. We shall, therefore, have to start with simple common-sense management and shall have to leave the development of better forestry methods to future years, providing only the opportunity to obtain the knowledge and experience necessary for the best results.

The main difficulties to be met for the present are those arising from social, political, and economic conditions. The social and economic conditions of our Western mountain States are peculiar, but they are easily understood and explained when we realize that on their 1,000,000 square miles not quite 3,000,000 inhabitants are to be found, or only 3 to the square mile, and if we deduct the population of the cities, a little more than 3 to every 2 square miles. The scarcity of population, together with the spirit of independence and self-reliance born in and remaining from the pioneer days, when each one, single-handed, had to stake out and defend his own homestead, and in order to provide for

himself and family in the wilderness was under the necessity of using natural resources freely, accounts for the prejudice against the curtailment of accustomed and at one time necessary privileges. A feeling of freedom is created in him who finds but little friction with neighbors; he becomes a law unto himself; government, with which he has but little touch, and which does not understand him nor benefit him, appears to him often an unnecessary and undesirable restriction, and he readily places the laws of necessity, as he conceives them, above the laws of the land.

If this spirit exists in the bona fide settler and citizen, it exists to a still greater degree, bordering on absolute lawlessness, in the irresponsible class of adventurers which a new country always attracts, especially when the laws are incompatible with existing conditions or are poorly and unsatisfactorily administered, for lack of discretion on the part of officers or for lack of proper machinery. We can not deny that there has been much in the past administration of the land and especially the timber question by the United States Government to lead Western communities to chafe under even proper restrictions, and to believe a change for the better impossible or impracticable.

One striking difficulty in establishing the reservations themselves may be found in the fact that much of the land that should be reserved is as yet unsurveyed; other parts are subject to prior rights, or are expected to be included in railroad grants. Their reservation will be objected to on that ground, or they will have finally to pass out of the reservation; in fact, to make a thorough success of the movement and to establish a thoroughgoing, proper forest policy it may, in my judgment, eventually become necessary not only to reserve all the remaining timber lands, but also to buy up such interspersed parcels held by private owners as destroy the compactness of the reserves and thereby impede their economical management.

It is an old experience that the greatest difficulty in breaking up old and introducing new methods comes from the momentum of habit and established usage; the resistance of the momentum to a change of direction increases with the increase of friction. Hence, to make innovations successful, they must not be made abruptly, but must adjust themselves as much as possible to existing conditions and be allowed to develop gradually into new systems. The spirit, then, which will oppose any new policy that smacks of restriction must be overcome by judiciously legalizing such uses as are permissible and controlling their exercise with the least friction. To make such a control possible, officers of discretion, tact, and at the same time strong administrative capacity, are necessary, and legislation devising management must be content to indicate general principles only, leaving the details to the administrative officers.

The management must provide—

(1) Proper organization and efficient service.

(2) Protection against theft, fire, or other damage of the property.

(3) Regulation of the occupancy and the use of the reservation by citizens.

(4) A system for cutting the crop and marketing it according to the needs of the population.

(5) Reproduction of the crop and maintenance of proper forest conditions.

It has been suggested that the Army be utilized to do duty on these reservations. Such employment, as a matter of temporary expediency, may be preferable to no supervision, but if the objects of the

reservations are to be fulfilled this can certainly not be expected from an agency established for entirely different purposes. While, then, admitting that admirable protective service may be done by the Army to bridge over the period of insufficient civil administration, I shall consider civil administration as the only one promising ultimate satisfaction.

One point needs to be constantly and strenuously insisted upon—that no management can be successful unless it be provided with proper machinery. Without managers there can be no management, and without guards there can be no protection. Hence a well-organized force of officers is a *conditio sine qua non*. As usual, it is the question of men, not of measures, that presents the real difficulty.

Without elaborating too far, I would propose an administration like the following:

PERSONNEL.

Assuming that so many reservations should be made as to render a separate administration of the same desirable, I would suggest either a central bureau, coördinate with the General Land Office, working in coöperation with the latter as far as necessary and desirable, or else a bureau in the Department of Agriculture. Each reservation should be under the direct control of a superintendent, residing on or near the reservation, and responsible for its protection and the enforcement of regulations, with the aid of a number of rangers, acting as patrolmen, each of whom should be responsible for a given district, the site of this to depend upon local conditions, ranging from 5,000 to 15,000 acres and more.

It is essential that all the local officers should have sheriffs' power, and should be clothed with considerable discretion in the enforcement of regulations. There would be little promise of a successful change of existing conditions if appointments of these officers were made by political preferment. Management of forest property more than of any other requires permanency of position, peculiar fitness, and love for the arduous tasks it involves. Hence, to secure efficiency I would propose to introduce some method of having the superintendents appointed as are judges, with such permanency of position as their fitness and good behavior should insure. The rangers, then, should be appointed upon the recommendation and certainly to the satisfaction of the superintendent, for the one who is responsible for the safekeeping of a property should have some voice in the selection of his assistants.

In addition to these safeguards of efficiency, a system of inspection must be arranged by which all local offices and their business should be frequently and thoroughly inspected. The secret of the remarkable efficiency, and especially the honesty, of the Prussian Government departments lies not so much in the moral superiority of the officers as in a thorough system of inspection. These inspectors, acting partly as advisors to the central bureau, would each have a number of reservations under their inspection, which they should visit at least three or four times a year, so as to keep the central administration in constant touch with the local needs.

Since we begin simply with common-sense management, not much forestry knowledge need be expected from the officers. If the three or four inspectors command a knowledge of the principles of forestry it will suffice for the first; while the local officers should have above all administrative capacity and a general knowledge of wood craft.

As the captain in the German army is the most important officer and in his efficiency lies the secret of successful warfare, so in the superintendent of the reservation and his efficiency rests the ultimate success of its management. His duties will be arduous, his position most responsible and difficult; and in the selection of the right man for this place, therefore, lies the promise of success.

REGULATIONS.

In regard to the regulations for the reservations, only a few hints may be made here. There is this condition in the States in which reservations would be made, that, in order to foster their unimpeded development, settlers for every acre of fertile land are needed; hence it becomes necessary, in the reservations of large extent, to segregate the agricultural lands and restore them to that part of the public domain which is to be disposed of for settlement.

It is also necessary for the present to give as much as possible unrestricted opportunity to prospect for minerals on these reservations and to arrange methods by which the opening of mines can be allowed and free development of mineral resources secured without destroying the legal status of the reserve.

Hunting and fishing should also be only so far restricted as to enforce the State game laws, except on smaller reservations nearer settlements, when special regulations should provide checks against waste and wanton extirpation of the game and fish.

In order to insure the good will of such temporary occupants of the reservations and their recognition of the reservation as such, it is suggested that a simple permit be obtained by every such occupant, either from the office of the superintendent or else from any of the rangers, whenever and wherever met, the permit card to state the name and residence of the holder, and, in brief, the regulations governing the reserve, the holder to subscribe to the regulations when obtaining the permit. A more than temporary occupancy should be granted, of course, only by the central office upon the merits of the case.

The regulations as to the use of fire, etc., should be drafted by the superintendent with due regard to the requirements of local conditions and their approval by the central bureau, and posted through the reservation according to needs. Gradually a boundary survey of the reservation and plats of its parks should be made by the rangers, and the boundaries should be properly marked.

TIMBER LICENSES.

A system of licenses to cut timber should be established, taking cognizance of the various needs in that direction. The system proposed in the Senate bill No. 1779, Fiftieth Congress, by which provision is made for a settler's and a prospector's license, at nominal fees, to supply their needs directly, and two classes of lumbermen's licenses for larger and smaller amounts, and varying charges of stumpage, seems perfectly feasible and equitable.

Perhaps with single and small reservations, and especially such as have been reserved with a view to the preservation of natural scenery, the restriction may be to issue licenses only to those cutting for domestic use, and more care would be required of the superintendent in assigning the places where cutting is to be done.

Two considerations must always be kept in view in this part of the management, namely, the needs of the consumer and the condition, present and prospective, of the reserve. The former should never be satisfied to the detriment of the latter, but all reasonable wants should be satisfied as far as possible.

Whatever system of administration and management may be devised, it will have to be simple and tentative. capable of gradual development into a more comprehensive system, with the application of finer methods of forestry added, as experiment and experience shall indicate them.

REPORT OF THE ENTOMOLOGIST.

INTRODUCTION.

SIR: I have the honor to present herewith my annual report as Entomologist for the calendar year 1891. I have thought best to confine it almost entirely to a full summary of the work of the division during the year, but on account of the interest felt in the subject I have given a history in some detail of the locust appearances during the season, which caused so much alarm in many of our western States. In view, also, of an expressed wish to that effect, and of the constant demand for this kind of information, I have brought together a paper on the more important insecticides now in general use by well informed persons against injurious insects. The section entitled "Work of the Season" has been committed to the charge of my first assistant, Mr. L. O. Howard, while in the preparation of the paper on "Insecticides" I have had the assistance of Mr. C. L. Marlatt, the paper being based upon the material which I have for some time been bringing together with a view of ultimately publishing a complete report or bulletin upon this practical phase of the divisional work.

The correspondence and routine work of the division have been greater than ever before, over five thousand letters having been written to correspondents, largely in answer to inquiries concerning injurious insects and the means of dealing with them; and this does not include the many letters in relation to publications, which are chiefly answered by circular. Large additions to the National Collection have been made, not only through the work of field agents but by donations from correspondents and collectors both at home and abroad, by exchange, and by small purchases. The growing value of such a national type collection to facilitate the work of the division becomes more and more apparent. Indeed, the work of determining specimens for entomologists in different parts of the country, and particularly for those connected with the experiment stations, has grown upon our hands until it has become to some extent burdensome, involving not only much of my own time and labor but that of some three assistants. This is without doubt an important and legitimate part of the divisional work, as it facilitates that of the experiment stations in the formation of their own collections, but it is a work for which the division gets little credit, and which does not indicate by its results the amount of time and labor expended.

Insect Life, the periodical bulletin of the division, has been published through the year, and meets with the heartiest encouragement from agriculturists, horticulturists, and entomologists. It affords an admira-

ble channel for the publication of short, interesting, notes which otherwise might be buried for years in the notebooks of the division. The other publications of the year have been Bulletin No. 7, The Pediculi and Mallophaga affecting Man and the Lower Animals, by Prof. Herbert Osborn; Bulletin No. 23, Reports of Observations and Experiments in the Practical Work of the Division, made under the Direction of the Entomologist; Bulletin No. 24, The Boll-worm of Cotton—A Report of Progress in a supplementary Investigation of this Insect, by F. W. Mally; Bulletin No. 25, Destructive Locusts, by C. V. Riley, and Circulars Nos. 1 and 2, new series. This new series of circulars has been started with the idea of lessening the extent of correspondence upon subjects of the most frequent question. No. 1 contains certain condensed information relating to insecticides, while No. 2 relates to the life history and remedies for the hop plant-louse. The latter was called for by the appearance of the hop plant-louse in great numbers early in the season and a threatened repetition of the great damage done by this insect in 1886. In addition to these publications, the Fifth Report of the U. S. Entomological Commission has been issued and distributed. It is a general consideration of the insects affecting forest and shade trees, and is a large volume of nearly 1,000 pages, illustrated with 40 plates and over 300 text figures.

The final publication and distribution of this report bring to an end the work of this commission, which was in active existence but five years. It is with some pride that I record here the fact that a commission composed of but three persons prepared and published for each of the five years of its existence a large and fully illustrated volume, and that the five taken together represent an amount of original investigation and experiment the practical outcome of which has, in my judgment, certainly never been excelled in the annals of economic entomology.

Respectfully submitted,

C. V. RILEY,
Entomologist.

Hon. J. M. RUSK,
Secretary.

THE WORK OF THE SEASON.

The season as a whole has been rather a busy one, entomologically speaking. A number of species of destructive locusts have been prevalent in different parts of the country, and a number of insects of lesser economic importance have increased injuriously, and important work has been done in the way of remedial experimentation, in the study of the life histories of different species, and in arrangements for future work.

A NEW INSECTARY.

The most important step which has been taken in recent years in the way of extending the facilities for the investigations of this division is the building of a new insectary, which has been carried on and completed the present year. The division has always been cramped for space and for many necessary facilities for the study of living insects in confinement but at the same time under more or less natural conditions. Indeed, of late years, several of the State experiment stations have been

placed in better condition for work in this direction than the National Department. The building which has just been completed is small, but will be sufficiently large for the purpose for which it is intended for a number of years to come. It is situated on the Department grounds, just east of the brick building known as the "seed building," and consists of a brick and stone structure of basement, first story, and high attic, 38 feet front by 21 feet deep, and connected with a conservatory 20 by 45. The conservatory was erected by the Lord & Burnham Company, of Fishkill-on-Hudson, N. Y., and contains all of the most modern greenhouse facilities for shelf room, heating, and ventilation. It is divided into two equal sections by a transverse glass partition, and each of the sections is heated independently, so that the one may be left at the normal outdoor temperature while the other may be heated to any degree desired. One may be called a hibernating room and the other a forcing room. In the basement of the brick building are a room for insecticide experiments, a store room, and a cold room. The first floor is divided into two large rooms, with a wide central hall. These rooms are to be used by the assistants permanently located in the building, and will contain shelving for the bred material, necessary books, and implements. One room may be devoted to apicultural purposes, should it be decided to carry on this work experimentally at Washington. The large light attic contains a dark room for photographic work, and a bacteriological laboratory, which will be thoroughly equipped. The conservatory will be fitted up with the most approved arrangements for the study of insects in the way of breeding cages and jars, and certain apparatus never before used is being developed.

There is no reason why, with the present arrangements, the most admirable results in the study of living insects should not be obtained.

THE FLUTED SCALE AND THE AUSTRALIAN LADYBIRD.

Some difficulty has been experienced during the past year in keeping on hand in California a good supply of Icerya to enable the division to feed the Australian ladybird and keep a certain number of this important insect on hand in case the fluted scale should make another destructive appearance in other parts of the Pacific coast, or in case, as has already happened, this Department is appealed to by other Governments for a supply of Vedalia. This has been accomplished, however, by one of the California agents of this division by constructing, under instructions, a strong tent inclosing an infested tree, and by constant watchfulness and renewal of the supply of scale-insects. The California State board of horticulture has also accomplished the same result by the construction of a small glass house over a growing orange tree. The fluted scale is still found occasionally in parts of California, but in very small numbers.

During the season small supplies of Vedalia have been sent, upon specific application, to New Zealand, South Africa, and to Egypt; in the first two cases for use against *Icerya purchasi* and in the last for experiment with the Egyptian Icerya (*Icerya ægyptiacum*), a closely allied species. None of the sendings have been successful, and the insects have arrived at their destinations in a moribund condition. A lesson has been learned, however, from this experience which will insure for future sendings a greater certainty of success. The government of the Cape of Good Hope has deemed this matter of such importance that a special representative of the agricultural interests of the colony in this country was specially instructed to carry back, if possible,

with him living specimens of Vedalia. This representative, Mr. Thomas A. J. Louw, a member of the legislative assembly of the colony, was, on his visit to Washington, furnished with letters to Mr. Coquillett, the divisional agent at Los Angeles, Cal., who was instructed to use every endeavor to secure the material for a large sending in Mr. Louw's care. At present writing the success of this sending can not be anticipated.

Encouraged by the wonderful success of the introduction of Vedalia from Australia and New Zealand into California by this Department, the California legislature last winter appropriated the sum of $5,000 to send an agent once more to these and other neighboring countries for the general purpose of collecting and importing into California other beneficial insects. The appropriation was placed in the hands of the State board of horticulture, and this board appealed directly to the Secretary of Agriculture to have Mr. Albert Koebele, the special agent of this division, who had charge of the former mission, sent on the present expedition, placing the entire sum appropriated at the disposal of the Department. Upon receiving the consent of the Secretary of Agriculture, Mr. Koebele was instructed by the Entomologist as to the most promising directions in which to work in order to make a success of his mission. The opportunity was taken at the same time to instruct him to carry to New Zealand and Australia certain beneficial insects of this country which might become acclimated and destroy certain injurious pests in these colonies, and thus repay in some part the boon which they conferred upon us in the shape of Vedalia. Mr. Koebele took with him several species of ladybirds, which prey upon plant-lice and bark-lice, several enemies of the codling-moth and parasites of the black scale (*Lecanium oleæ*) and the flat scale (*Lecanium hesperidum*).

Mr. Koebele sailed on the August steamer, stopping at Honolulu and Auckland, and arriving at Sydney the latter part of October. At Honolulu he left a number of living specimens of *Chilocorus bivulnerus* in the hands of our correspondent, Mr. A. Jaeger, and secured while there four species of ladybirds, of which he sent small numbers to California by steamer. These were sent for use against the black scale (*Lecanium oleæ*). He also found a few parasitic Chalcididæ on an undetermined Lecanium, and of these he sent a few specimens. Upon his arrival in New Zealand some of the ladybirds which he had taken with him were alive and began to feed at once upon woolly aphis. Some syrphus-flies and lace-wing flies were also in good condition, as were also the larvæ of the Rhaphidia, which feeds upon the codling-moth. These were left in the charge of a competent person. Specimens of *Scymnus acceptus*, *S. consors*, *S. villosus*, *S. flavihirtus*, and *S. fagus* were collected and sent to California. These all prey upon various species of scale-insects, but it is hardly to be supposed that they will accomplish any better results in California than do our native species of this genus, all of which have similar habits.

The most encouraging information comes to us under date of November 1 from Sydney. He there finds that *Orcus chalybeus*, a steel-blue ladybird, is a most important enemy of the red scale. He has found them by the hundreds, and has observed the mature insects eating the scales. All of the trees were "full of eggs," and the larvæ were swarming upon all the orange and lemon trees infested with the red scale. He secured and sent a large lot of the eggs and many of the adult beetles. He also sent the allied *Orcus australasiæ*, also found feeding upon the red scale, and a number of Scymnids, one of which was very numerous and also feeding upon the same scale-insect. Another species was found feeding mainly upon the flat scale (*Lecanium hesperidum*) and

the black scale (*Lecanium oleæ*). He also forwarded a number of *Leis conformis*, which, as stated in Bulletin No. 21 of this division, is the commonest enemy of the woolly root-louse of the apple. Unfortunately, Mr. Koebele does not state whether the three insects mentioned as feeding upon the red scale are successful in holding that destructive insect in check, and upon this point naturally depends much of their value to California. Our agent at Los Angeles, Mr. D. W. Coquillett, has been instructed to spare no pains to properly care for and colonize whatever may be received from Mr. Koebele, and is fully prepared to do so. This last sending arrived at Los Angeles, we are sorry to state, in rather bad condition. Twenty-eight beetles, however, were alive, including nine of *O. chalybeus*, and no effort will be spared to keep them in good condition and to induce them to propagate.

The species of Orcus have already been mentioned by Mr. Henry Tryon, in his first "Report on the Insect and Fungus Pests of Queensland" (Brisbane, 1889), as voracious feeders, both as larvæ and as adults, on scale-insects of several species, and there can be no doubt that with their successful acclimatization in California a very valuable genus will have been added to our ladybird fauna.

IMPORTATION OF EUROPEAN PARASITES OF THE HESSIAN FLY AND THE IMPORTED CABBAGE-WORM.

A careful study of the European parasites of the Hessian fly was made some five years since by Dr. K. Lindemann, of Moscow, Russia, who described several new species, the most important being *Semiotellus nigripes*, a form congeneric with the most abundant of the American parasites of this destructive wheat pest.

During the summers of 1886 and 1887 the Hessian fly was very abundant in England, and during the latter season Prof. Riley was present in that country and had an opportunity of studying the parasites, which were gradually multiplying and reducing the numbers of the fly. The most abundant was recognized as identical with Dr. Lindemann's species just mentioned, and he at that time conceived the idea that this parasite might be of practical value to the wheat-growers of the United States. This idea was based largely upon the well-recognized fact that European insects, as a rule, when introduced into this country, multiply in excess of their normal home abundance, and, when plant-feeders, speedily become very injurious.

It was not until the early spring of 1891, however, that he was able to carry out this plan, At that time two lots of Hessian-fly puparia ("flaxseeds") infested with this parasite were received from Mr. Fred Enock, of London, a gentleman well known for his microscopic preparations, and who of late has taken great interest in the study of the Hessian fly. The greater part of these infested puparia were divided between our agent, Mr. F. M. Webster, at La Fayette, Ind.; Prof. S. A. Forbes, Champaign, Ill., and Prof. A. J. Cook, Agricultural College, Mich., as these three gentlemen were well situated for the proper placing and care of the parasites. Later, at the request of the Entomologist, Prof. Forbes, having more than the others, sent a small supply to Mr. James Fletcher, Dominion entomologist of Canada, Central Experiment Farm, Ottawa, Canada. In the case of all except Prof. Forbes we have either received no report, or the parasites were simply liberated under such conditions as to warrant the expectation of continuous breeding. Prof. Forbes, however, has reported, and in his case progress has been gratifying and the outlook is favorable.

The parasites were placed in a gauze cage (in the open air) containing a plat, 2½ by 3 feet in size, of badly infested wheat. Two lots were placed in this cage, the first on May 7 and the second on May 11. By the end of June freshly emerged parasites began to be noticed, and there can be little doubt but that these were the offspring of the individuals placed in the cage, so that one generation at least has developed upon American soil. Parasites of this new generation continued to emerge until August 29, and most of them (77) were released in a field of moderately infested wheat stubble on the experimental farm of the Agricultural Experiment Station at Champaign, Ill. In the meantime, however, and before all of the parasites had issued, about two-thirds of the parasitized puparia found in the cage were carried to Scott County, after search had been made in several localities for a favorable place, and were placed upon the farm of Messrs. Edwin and Frederick Vantyle, 3 miles northeast of Roodhouse, in a piece of stubble which the owners agreed to leave unplowed. This field had been badly damaged the present season and was not damaged last year, so that there was consequently little probability of excessive native parasitism. Forty or fifty specimens of the European parasite had completed their transformations on the journey to Scott County, and escaped from the box when it was opened in the field; but, as before stated, specimens continued to emerge from the check-lot retained at Champaign for some weeks after this distribution. Careful watch will be kept on the Champaign plat and on the Scott County plat next year, and a reappearance of the imported parasite is confidently expected.

The Entomologist will not rest content with this first attempt, but with Mr. Enock's kind assistance will doubtless be able to import other specimens the coming spring.

In 1875, while in London, Prof. Riley solicited, at a meeting of the London Entomological Society, the assistance of members in importing the commonest of the European parasites of the imported cabbage-worm (*Pieris rapæ*), viz, *Apanteles glomeratus*. This parasite spins conspicuous yellow cocoons in masses and hibernates in these cocoons, so that it is an easy species to collect and transport to any part of the world. In the early eighties Mr. Otto Lugger, then connected with the Maryland Academy of Sciences in Baltimore, while on a trip to Germany, gathered three pints of these cocoons, which he subsequently scattered in some cabbage fields near Baltimore. This experiment was probably a failure, as none of the parasites were found the following year. In 1884 and 1885, however, the Entomologist accomplished an undoubted success, as detailed in his annual report for 1884 (p. 323). Cocoons received from Mr. G. C. Bignell were placed in a cabbage field near the Soldiers' Home at Washington in the spring of 1884, and in the late fall the species was found to have developed and spread to other portions of the field.

Owing probably to the recent rather extensive importation of cabbages from Europe, largely necessitated by the ravages of *P. rapæ* in the United States, this parasite has no doubt been accidentally imported into this country on several different occasions, and has become more or less firmly established at several different points, as Prof. Riley has shown on page 1899 of Scudder's "Butterflies of the Eastern United States and Canada." Moreover, there is considerable difficulty in distinguishing between this parasite and a variety of the common *Apanteles congregatus*, known as *pieridivora*, and which has probably become a variety, through a change of feeding habit, from Sphingid larvæ to the larvæ of the butterflies of the genus Pieris. This fact will render nec-

essary the closest investigation of any reported occurrence of *A. glomeratus* in this country. As stated (*loc. cit.*), specimens have been reported from Albany, N. Y.; Brownsfield, Me.; Adrian and Lansing, Mich., and Columbus, Ohio, so that these localities, in addition to the District of Columbia, are definite.

Early last spring a number of cocoons of *A. glomeratus* were received from England, and after retaining a few at Washington, the remainder were divided between our agents, Prof. Herbert Osborn, at Ames, Iowa, and Mr. Lawrence Bruner, at Lincoln, Nebr. Prof. Osborn was away from home on the receipt of the specimens, and on his return the imagos were already issuing, although it was so early that no cabbages had been set out. He placed the unbroken cocoons, however, upon wild mustard, where the cabbage-butterfly was most likely to oviposit. No evidence was noticed to the effect that the parasites had secured a foothold until August, when they were found in numbers, and some of them at a distance of 2 miles. The insect thus seems to have spread very rapidly, and Prof. Osborn states that it has obtained such a decided hold on the cabbage-worm that he doubts whether there will be much material for it to work upon another season. There is some evidence that this parasite was already present in the neighborhood last year, but its great increase is probably due in part to the importation. Mr. Bruner placed the specimens which he received in the market garden of a friend just outside of the city. Cabbages had already been set out and the butterflies were beginning to be quite numerous, although no eggs had been laid at the time. He has not yet reported upon the success of the experiment, but there is already warrant for other attempts in the future. We may state, in passing, that specimens of this parasite have also been received from Miss Murtfeldt, of Kirkwood, Mo., where there has probably been an accidental importation.

THE GYPSY-MOTH AND ITS PARASITES.

The accidental introduction some twenty years ago of the gypsy-moth (*Ocneria dispar*) into New England and its sudden spread during the year 1890 is now a matter of common history. The legislature of Massachusetts appropriated a large sum of money for work against this new pest, and appointed a special commission to superintend the work. During the year 1891 the personnel of this commission was changed, and the Entomologist was asked to be present at a session to discuss the best methods of extermination, held at Boston in the rooms of the committee of agriculture, March 4. A full report of the discussion at this meeting was printed on pages 368–379, Vol. III, of Insect Life. Later visits to Boston have also been made to follow the workings of the commission and to consult with its members. The matter is referred to here particularly for the reason that a proposition has been made to endeavor to import the European parasites of this insect also. A study of the literature concerning the known European parasites shows that while some good may be accomplished by such an attempt, it is liable to comparative failure from the reason that none of the parasites are specific foes of this insect. They attack other large Lepidoptera of different families, and their energies thus become dissipated. If a specific enemy could be found, its introduction would be a matter of great moment. Even as it is, however, the Entomologist has urged the sending of an expert to Europe for the purpose of collecting such parasites as do exist.

In the fall of 1890 a most interesting communication from Rev. H. L.

Loomis, of Yokohama, Japan, was received, stating that the gypsy-moth had been abundant and destructive in his garden, but that it had been destroyed by a parasite of which he sent specimens. This parasite proved to be a species of the genus *Apanteles*, differing from any of the European gypsy-moth parasites of this genus and forming, in fact, a new species. Mr. Loomis visited this country this season, bringing with him a few specimens of this parasite, which he sent to the board of agriculture in Boston. We have not learned of the disposition which was made of these specimens, but Mr. Loomis has promised on his return to send others, so that they can be utilized, if possible. The trip from Yokohama to Boston can now be made in eighteen days, so that there should be no difficulty in bringing over the parasites in good condition.

It may be mentioned that unverified reports of the occurrence of the gypsy-moth in the State of Maine have been received the present season, indicating an unexpected spread of the species.

DAMAGE BY THE LARGER CORNSTALK AND SUGAR-CANE BORER.

This insect, scientifically known as *Diatræa saccharalis*, has received some treatment in previous publications of this Department, notably in the Annual Report for 1880 and in Special Report No. 11. Although for many years known only as a borer in sugar cane, it has been found in many sections of the country where sugar cane is not grown, and as early as 1881 it was known to do considerable damage at times to corn as far north as South Carolina. In 1890 we received notice that the corn crop in the neighborhood of Fredericksburg, Spottsylvania County, Va., was suffering from the attacks of a new pest, and specimens received showed that species to be the author of the damage. In July, 1891, further specimens were received from King George County, and during this month and the following, two of the members of the force made trips to the infested region and carefully examined the insects at work, together with the conditions and surroundings. The writer treated the subject at length in a paper read before the meeting of the Society for the Promotion of Agricultural Science, held in Washington during August, and subsequently published upon pages 95–103 of Vol. IV, Insect Life. From these observations it appears that the early planted corn was much more badly infested than the late planted. That planted during the first half of April was frequently reduced 25 per cent. Corn planted after the 1st of June was not infested to any extent. The average injury to crops planted upon land which was in corn last year was 25 per cent, while that to corn planted upon sod land was only 10 per cent. There seem to be at least two annual generations, and all known facts point to the hibernation in the pupa state in the stubble.

With favorable seasons this insect will doubtless become a serious enemy to this important crop, throughout this section of the country at least, unless remedial measures are at once undertaken. The almost universal custom in Virginia and the Carolinas of leaving the stubble (if not the old stalks) in the ground through the winter affords easy and safe hibernation to the insect. There will always be danger of serious loss where this plan is followed. If the stubble is systematically removed and burned after harvest or during the winter by the farmers of a given neighborhood, or if a constant rotation of crops is practiced, the damage by this insect will be reduced to the minimum.

In sugar cane this species has been doing considerable damage the

past season on the experimental grounds of the sugar station of this Department at Runnymede, Fla., and during October an assistant (Mr. Banks) was sent to examine into the conditions. It was found that in most of the plats the growth of the cane had not been stopped, and was probably but slightly checked. In a few patches, however, the worms had done considerable damage and in some rows had stopped all terminal growth. Plant cane seemed to be more damaged than stubble cane. The climate in that part of Florida is so warm that there seems to be no definite period of hibernation, and consequently the methods adopted in parts of Louisiana of destroying the hibernating pupæ or preventing the issuing of moths from them by burning all tops, trash, and volunteer cane, and planting seed cane in the fall, leaving no open mats of seed, can not be followed to advantage here. Some other method must be devised, and this we hope to accomplish after field study a little later in the season.

Observations the present season show that this same insect feeds in Virginia in the "gama" grass, or the "sesame" grass (*Tripsacum dactyloides*), a tall stout grass that grows along water courses. In this plant, however, the worms choose by preference the upper section, and have even been found feeding in the seed-head; whereas in corn, sorghum, and sugar cane they prefer the lower internodes, and, in case of the first brood upon corn, work well down into the tap root. Where cornfields border streams, therefore, it will be necessary to burn over, during winter, any patches of this grass which may be found.

SPREAD OF THE HORN FLY.

Up to the present season the horn fly had not been reported to us outside of southern New York, New Jersey, eastern Pennsylvania, Delaware, Maryland, and eastern Virginia. Its first importation, as we stated in our original article upon this insect, seems to have been at some point in New Jersey near New York City, and the regular trend of its spread from this point for some years was toward the south in the Atlantic States only. From the fact that the direction of cattle freightage is almost entirely from the west eastward, it seemed unlikely that the insect would spread toward the west except gradually by flight. But probably by the sending west of choice stock from Baltimore the fly has made its appearance the present summer in Ohio and Kentucky, and even as far south as Mississippi, and will doubtless be heard from next season considerably farther west. In fact, we learn from Prof. Herbert Osborn, of Ames, Iowa, that during the past season there has been an unverified rumor of its appearance in the State of Iowa, but of the accuracy of this rumor we have considerable doubt.

On page 144, Vol. IV, Insect Life, we published a letter from Mr. P. T. Henshaw, of Oldham County, Ky., dated August 20, in which he reports that the fly has been noticed in his vicinity the present season in injurious numbers. All the stock-raisers of the vicinity noticed unusual numbers of a small fly on their cattle during the summer, and, according to Mr. Henshaw, the stock on delivery weighed from 100 to 150 pounds per head less than they should have weighed. In fact, after three months' grazing the average gain was not over 50 pounds per head, when it should have been that much each month.

At the meeting of the Association of Economic Entomologists, held in Washington, August 18, Prof. D. S. Kellicott, of Columbus, Ohio, read a note reporting the occurrence of the fly in great numbers on the farm of Mr. A. Freed, Pleasant Township, Fairfield County. Large

patches were seen upon the backs and about the horns of the cattle. At Sugar Grove, 8 miles south, a few were found, while at Rockbridge, 4 miles farther down the Hocking Valley, none were to be found. He was of the opinion that there were none north of Pleasant Township, but from his observations he thought that it was spreading southward from near Lancaster, and that it had been introduced by transportation in cattle cars from the East.

The publication of this note by Prof. Kellicott in Insect Life, Vol. IV (p. 35), brought us a letter from Mr. M. T. Phelps, of Ashtabula County, in the northeastern corner of the State of Ohio, in which he stated that the horn fly troubled cattle in his neighborhood a little during 1890 and was very troublesome during the summer of 1891, collecting in large numbers on the horns, upper parts of the shoulders, and inside of the fore-legs.

With regard to the occurrence of the fly in Mississippi, we learn from Mr. H. E. Weed, the entomologist of the Mississippi Agricultural Experiment Station, that it appeared early last May in a herd of cattle at Macon, Noxubee County, in the eastern part of the State, and on the line of the Mobile and Ohio Railroad. Mr. Weed was first notified of this fact in October, and visited Macon in November and verified this statement. Answers to an inquiry which he published in the Southern Live-Stock Journal showed that the insect is now present in nearly all the eastern portions of the State, most of the farmers estimating the consequent decrease in the yield of milk at about one-half.

Several of our correspondents have found that the use of the standard kerosene emulsion is tolerably efficacious in warding off the flies, where it has been carefully sprayed upon cattle by means of a knapsack spraying pump, at intervals of from three to seven days, and at the meeting of the Association of Economic Entomologists just referred to a note was presented by Mr. W. B. Alwood, of the Agricultural Experiment Station at Blacksburg, Va., in which he stated that the emulsion diluted ten times and mixed with one part of a water extract of tobacco waste (1 pound of tobacco to 1 gallon of water) gave almost perfect immunity for a period of three days, and that two treatments per week almost entirely relieved his cattle from annoyance. He makes the application with a knapsack pump fitted with a "cyclone" nozzle, and the work is done just after milking time in the morning. Two men treat the cows rapidly, requiring about one minute per cow and using one or two pints of liquid for each animal.

HOT WATER FOR THE ROSE-CHAFER.

Considerable attention has been attracted the present season by the announcement that the rose-chafer is peculiarly susceptible to the action of hot water. This matter was first brought to the attention of the division by Mr. D. O. Kellogg, of Vineland, N. J., who wrote, under date of June 8, 1891, that he had made the discovery that water heated to even a comparatively low temperature will kill the beetle. He was led to this discovery by the fact that vegetable infusions with which he had been experimenting were efficacious when warm and useless when cold. As one of our Virginia correspondents, Mr. J. S. Strayer, of Port Republic, was just then complaining of the ravages of this insect, he was asked to experiment with this method, and he reported perfect success. On June 12 Mr. Kellogg wrote again, stating that further tests confirmed his anticipations, and asking the Entomologist to take the matter in hand and have a machine perfected for the application of

steam. The efficacy of hot water seems to have been independently discovered by Mr. E. S. Carman, of the Rural New-Yorker, who published in his journal of June 27 an editorial account of the means by which he had arrived at the discovery. He noticed that during the hottest part of the day the insects sought shelter, and, collecting a few, he placed them in a white paper box and exposed the box to the direct rays of the sun. He found that they were killed in an hour or so. He then experimented with hot water and discovered its efficacy. Other experiments were made with a spray pump, and Mr. Carman concluded that a comparatively close spray of 125° F. will invariably destroy the insect.

Prof. Riley immediately instituted experiments in Washington, and was surprised to find, in view of the confidence in which the claim was made, that it was not very fully borne out. Experiments conducted by two members of the force, Messrs. Marlatt and Chittenden, showed that even at a temperature of 135° the beetles recovered after being immersed. Others sprinkled at close quarters with water at this temperature soon recovered. It is only fair to state, however, that two specimens immersed for one minute at a temperature of 125° were killed. This difference in results was difficult to account for, and the matter was of such interest that another assistant (Mr. Cordley) was sent to New Jersey for the purpose of experimenting on a larger scale not only with hot water but also with steam, as suggested by Mr. Kellogg, and as has also been done in the hop fields in England. Unfortunately, however, Mr. Cordley arrived upon the ground too late, and all but a few scattered specimens of the insect had disappeared.

On the first publication of the suggestion experiments were tried by other entomologists, notably by Prof. J. B. Smith, of New Brunswick, N. J., and Prof. A. J. Cook, of Agricultural College, Mich., and both of these gentlemen have reported that in their experience, where actually applied at a temperature of 125°, the insects were killed.

The discovery of this remedy is undoubtedly a matter of considerable importance, although the difficulties in the way of its practical application are very great. The extreme rapidity with which water will cool when broken into a spray would seem at first glance to render the method practically useless; but we must remember, in the first place, that a fine spray is not absolutely necessary and that even a solid jet can be used to advantage, and also that the difficulties in the way of using steam are not insuperable. There will be a considerable expense attached to the application of steam upon a large scale, as in an extensive vineyard; but the great loss which the rose-chafer inflicts upon the grape-growers of New Jersey and Delaware, and the fact that no other efficacious remedy has been found, will doubtless encourage large growers to give it a trial. Portable steam engines used for different purposes are abundant enough in any thickly settled country, and arrangements for piping the steam can readily be made.

LACHNOSTERNA EXPERIMENTS.

Although the "May beetles" or "June bugs" of the genus *Lachnosterna* and their larvæ, commonly known as "white grubs," are extremely abundant in all parts of the country and have also taken high rank as injurious insects, many points connected with their life history have never been made out. The Entomologist has, therefore, taken measures the present season to systematically and thoroughly investigate all

doubtful points. Recent studies, particularly of the male sex, have indicated that we have about one hundred species of the genus *Lachnosterna* in this country, instead of about sixty, as formerly supposed. It is probable that the main points in the life history of all will be very similar, but as many species as possible have been included in the experiments planned. Agents at Lincoln, Nebr., Cadet, Mo., and Columbus, Ohio, have collected the species as they have appeared in their neighborhoods, and have secured eggs from corresponding specimens under natural conditions. All have made arrangements to follow carefully the development of the larvæ hatching from these eggs. A similar series of experiments with several species has been instituted at Washington, and it is hoped that the results will justify the labor which the investigation will entail.

EXPERIMENTS WITH DORMANT SCALE-INSECTS.

The efforts of the California State board of horticulture to quarantine and disinfect plants imported into the United States, and the probability that similar efforts may be made by other official boards in other States in the future, render of value a few experiments which were instituted during the season at the Department for the purpose of disinfecting certain date palms imported by the Pomologist from Mediterranean countries for ultimate shipment to the extreme southwest of this country.

Insecticide washes which our experience has shown to be very successful against various introduced and native scale-insects in our orchards were found to be only partly efficacious. The scale-insect treated was *Parlatoria zizyphi*, a species which has a close dense scale which is applied so closely to the surface of the plant as to thoroughly protect the insect. The insects, moreover, were so thickly massed upon the plants that the underlying specimens were at first not reached by the insecticides. The experiment emphatically showed the necessity of abundant caution in all similar cases and the need of the most thorough and intelligent supervision. Two applications of the standard kerosene-soap emulsion were made, the first diluted fifteen times and the second, applied fifteen days later, ten times. Three days after the second application a considerable percentage of seemingly healthy scales remained. A third spraying of two trees was made with a kerosene emulsion diluted five times, with the result that all of the scales were killed, although the plants were somewhat yellowed and injured. Two more were sprayed with the resin wash made after Mr. Coquillett's formula, with no effect upon the scales. Eighteen days after the second spraying with kerosene the trees not further sprayed were examined, and it was observed that 5 per cent of living scales remained, showing that many specimens at first apparently unaffected had eventually succumbed. Thirteen days later it was found that no more specimens had died and that a few young had hatched. The plants were then thoroughly washed with a stiff brush, removing the dead scales, and then sprayed with a kerosene emulsion diluted eight times. Five days later this spraying was repeated, continuous rains having vitiated the immediately preceding experiment. This spraying apparently brought about the final extermination of the scales, but, as the trees were uninjured, they were sprayed once more before they were shipped to their destination. It will be noticed that the second spraying was practically successful, as only 5 per cent remained alive; but, when the question of introducing a new pest is involved, absolute extermination is necessary.

SCIENTIFIC MEETINGS AT WASHINGTON.

Most of the time of the divisional force was occupied during the third week in August by the meetings of the Association of Economic Entomologists, which were held in connection with the meetings of the Society for the Promotion of Agricultural Science and of the Entomological Club of the American Association for the Advancement of Science. Many entomologists were in attendance, and among them a large number of those connected with the agricultural experiment stations. Papers were read by several members of the office force, and much interest was shown by the visiting entomologists in the work of the division and in its methods and its collections and library. The meetings were also of advantage to the division, as it brought its members into close personal relation with other workers in the same line and laid the foundation for future interchange of ideas.

THE BOLL-WORM INVESTIGATION.

The field work of the boll-worm investigation, mentioned particularly upon pages 240–241 of the last Annual Report, has been closed up. Mr. F. W. Mally, the assistant in whose charge the field work of the investigation had been placed, remained at Shreveport, La., throughout the last winter and summer, with the exception of a short trip into Texas in October. Prof. Jerome McNeill, of Little Rock, Ark., was reëmployed during the summer in the work, mainly upon the subject of new insecticides. Mr. Banks, another assistant, was sent to Shreveport, where he remained assisting Mr. Mally during a portion of the season. A number of new facts concerning the life history of the boll-worm and its natural enemies, and concerning other insects whose ravages are frequently mistaken for those of the boll-worm, have been brought out by the investigation, and a number of the old remedies have been critically tested. The main work of the season, however, has been in the direction of experiments with contagious diseases, as stated in the last Annual Report. The solitary character and endophytic habit of the boll-worm render the artificial propagation and natural spread of a contagious disease very difficult. Should an individual become diseased, in the majority of cases it will die in the boll or ear of corn, and the rotting portions of the body containing the germs will be absorbed by the vegetable substance surrounding it. Experiments have been made, however, with a disease of the imported cabbage-worm (*Pieris rapæ*) and with one of the cabbage Plusia (*Plusia brassicæ*), and this latter disease has been found to exist occasionally among boll-worms without artificial introduction. A full report of the investigation is now in preparation and will be published as a separate bulletin.

APICULTURE.

As indicated in the introduction to this report, some apicultural work has been carried on during the season. Prof. A. J. Cook, of the Michigan State Agricultural Experiment Station, was commissioned January 1, 1891, for a period of six months, and Mr. J. H. Larrabee, of Vermont, was appointed to assist him. Experiments, some of them in continuation of those instituted previously by the Michigan station, were undertaken with a view of determining the value of special planting for honey, the effect on bees of the poison used in spraying fruit trees, the value of bees as fertilizers, the introduction of an improved

strain of bees, a determination of the amount of honey required to produce 1 pound of wax, whether the worker bees feed the drones albuminous food, and to determine the conductivity of wax. Among the results apparently proven by the experiments of the season we may mention the following: A number of honey plants were tested, and the conclusion was reached that none of them would pay for cultivation for honey alone. A second experiment indicated that spraying with arsenicals should not be carried on while the bees are visiting the blossoms of fruit trees. Another series of experiments showed conclusively the value of bees as fertilizers. The result from the next series of experiments seems to indicate that 11 pounds of honey is the amount required to produce 1 pound of comb. This result is at variance with the results obtained by other workers. The experiments made by Schoenfeld, in Germany, on the character of the food of drones resulted in the same conclusion, viz, that drones are given the same kind of albuminous food as the queens and the larvæ, and that without this food the drones can not live longer than three days at the outside. Experiments upon the conductivity of wax indicate that for practical purposes it has about the same as the board partitions of hives and rather greater than the full comb.

July 1 Mr. Frank Benton, a well-known apiculturist, was appointed for the purpose of conducting further investigations. Mr. Benton has been stationed at Washington since the date of his appointment, and has been engaged for the most part in placing the apicultural work upon a good footing and devising a series of experiments to be carried out during the next season.

OTHER INVESTIGATIONS.

A number of investigations of less importance, some of which have not been completed, have been carried on during the season. Of these we may mention a study of the insects injurious to the pecan in Texas, an investigation of the life history of a species of bill bug which has been doing considerable damage to corn near Philadelphia, and a long series of experiments with insecticides, and particularly with the kerosene-soap emulsions.

WORK OF THE FIELD AGENTS.

Mr. D. W. Coquillett, the field agent stationed at Los Angeles, Cal., was instructed in July to visit the portions of California infested by destructive locusts, and has reported in full upon his observations in that direction. His work is summarized, however, in a special article upon "Destructive Locusts" in this report. Mr. Coquillett's main work during the season has been a continuance of his studies upon the habits and natural enemies of the destructive scale-insects of California, and particularly upon the best methods of limiting their injury. Some additional work has been done with the gas treatment, but this was interrupted to a certain extent by the issuing of a patent for the process to private parties.

Since the destruction of the fluted scale by *Vedalia cardinalis*, probably the two most important scale-insects in California are the red scale (*Aspidiotus aurantii* Maskell) and the San José scale (*Aspidiotus perniciosus* Comstock). Mr. Coquillett reported last year upon a series of tests against the former, and this year gives a continuation of his experimental series tried against the latter. Combinations of sulphur, lime,

and salt, as described in the report of this agent for 1890, are the ones principally used in California against the San José scale. A careful series of experiments, however, carried on this season, showed that these washes are not as effectual as the standard resin wash made one-half stronger than when used on citrus trees. The latter, however, is used only during the dormant season, and in this respect deciduous trees have an advantage over evergreens. The main difficulty in all applications comes from the frequent rains at this time of the year. Further experiments were carried on with the resin washes to ascertain their effect upon deciduous trees during the summer season, with gratifying results. Further remedial experiments have been tried against the greedy scale (*A. rapax*) and the black scale (*Lecanium oleæ*). In addition to the scales mentioned, observations were made upon the oleander scale (*A. nerii*), the flat scale (*L. hesperidum*), the hemispherical scale (*L. hemisphæricum*), the frosted scale (*L. pruinosum*), and the brown apricot scale (*Lecanium* sp.). Many new points connected with the life history, food plants, and natural enemies have been brought out.

Mr. F. M. Webster, the agent formerly stationed at La Fayette, Ind., has been transferred to Columbus, Ohio, where he is located at the State Agricultural Experiment Station. This change was made July 1. In February this agent was sent to Arkansas and Texas to continue observations upon the various species of Simulium (buffalo-gnats and turkey-gnats) infesting the streams of the valley of the lower Mississippi, and also to investigate the depredations of the grape curculio in northeastern Arkansas, and further to look into the subject of insects infesting growing grain in Texas. A short narrative account of this report has already been published on pages 451–455 of Vol. III, Insect Life. Later he investigated several reports of insect damage in the State of Ohio, including one of the clover-hay worm, another of damage by crane-fly larvæ, another of the wheat-midge, and another of damage to the timbers of a large manufactory by wood-boring beetles. He has also assisted in experiments in the introduction of European parasites of the Hessian fly, and in experiments upon the life history of the white grubs. The main portion of his report is occupied with the consideration of several species of crane-flies, whose larvæ infest meadows and pastures, and which may also prove injurious to wheat. He treats of three distinct species, giving notes upon their habits and life histories, and recommends as the best remedy in cases where wheat is to follow clover to plow late in August, or at least before the middle of September.

The report of Mr. Lawrence Bruner, the agent stationed at Lincoln, Nebr., is mainly taken up with an account of his trips of observation upon the locusts, summarized in our article upon this subject. He also reports briefly on the subject of the injurious insects of the season in Nebraska, calling particular attention to the damage done by the corn root-worm (*Diabrotica longicornis*), the green-striped maple-worm (*Anisota rubicunda*), an injurious sawfly (*Lyda* sp.) upon wild plum, the gooseberry span-worm (*Eufitchia ribearia*), a few new sugar-beet insects, and the cabbage-butterfly.

The agent stationed at Kirkwood, Mo., Miss Mary E. Murtfeldt, reports that during the year 1891 the State of Missouri has suffered less from the attacks of insects than for many years previous. The insects attracting attention and upon which she particularly reports are different species of plant-lice, the chinch-bug, the joint-worm, the plum curculio, the harlequin cabbage-bug, cut-worms, cottony maple-scale, the post-oak Kermes, and several Lepidopterous larvæ. She includes

in her report some notes upon the natural enemies of certain pernicious insects. She has experimented, at our request, with the substance known as "thymo-creosol," made by a Baltimore firm, and found it efficacious against chicken lice, but would not recommend its general use as an insecticide. She finds that it is not sufficiently drastic to kill at once by contact, and that it is not speedily poisonous to gnawing insects if taken in with the food.

Prof. Herbert Osborn, the agent stationed at Ames, Iowa, in addition to a report upon the results of his trip to investigate locusts in Kansas during August (see Insect Life, Vol. IV, pp. 49–56), has continued his work on the insects injurious to domestic animals, and has reported upon the insects of the season in Iowa. From this latter report it appears that aside from the abundance of plant-lice, which multiplied greatly upon plums and wheat, and the spread of the clover-seed midge, there were no insect attacks of sufficient magnitude to attract particular attention or to cause serious alarm. He treats particularly the insects just mentioned, and the clover-seed caterpillar (*Grapholitha interstinctana*), the flavescent clover-weevil (*Sitones flavescens*), the imported parasite of the cabbage-worm (mentioned on previous pages), and the apple maggot (*Trypeta pomonella*). He also gives the results of a number of trials of a "hopperdozer," consisting of a simple flat sheet of sheet-iron, covered with coal-tar on the upper surface, and drawn by means of cords attached to each end. This proved a most efficient method of capturing jumping species of leaf-hoppers, young locusts, and other small insects. Actual tests showed that the insects captured by this method varied from 213,000 to 376,000 per acre. Hay raised upon treated plats proved to be 34 per cent better than that raised upon untreated plats. Four-fifths of the jumping insects present were captured by one drag. This investigation is an original one with Prof. Osborn, and is highly meritorious.

DESTRUCTIVE LOCUSTS.

Probably not since 1876 has there been such alarm felt throughout our western country upon the locust or "grasshopper" question as during the past summer. Correspondents of the division began sending in specimens early in June of species which were unusually abundant, and which they suspected might be the destructive Rocky Mountain locust (*Caloptenus spretus*). In July the newspapers contained many alarming reports from different parts of the West, and a serious investigation was begun. One of the field agents of the division, Mr. Lawrence Bruner, of Lincoln, Nebr., who, by virtue of his especial knowledge of these insects and the long training which he has had under the division in work of this character, was especially fitted for such an investigation, was sent on a general tour of inspection, first to eastern Colorado, thence through South Dakota, North Dakota, Minnesota, Montana, Idaho, Utah, and Wyoming. He also incidentally visited the Red River Valley in Manitoba. Prof. Herbert Osborn, of Ames, Iowa, another agent, was sent down into Kansas to investigate the reports from that State. Mr. Nathan Banks, an office assistant, who was at the time assisting in boll-worm work at Shreveport, La., was sent through Texas and into New Mexico, as alarming rumors had been heard from this southwestern country, and Mr. D. W. Coquillett, the agent at Los Angeles, Cal., was ordered to visit the localities in California from which rumors of locust increase had been received. During the progress of this work the locust

irruption in eastern Colorado was also investigated by Prof. F. H. Snow, of the Kansas State University, and Prof. E. A. Popenoe, of the Kansas State Agricultural College, these gentlemen having been sent out at the expense of an enterprising newspaper in Topeka. Prof. Otto Lugger, of the Agricultural Experiment Station of Minnesota, was actively engaged during the season in preventive and remedial work in his State, and Prof. C. B. Waldron, with Director Stockbridge, was doing similar work in North Dakota. Prof. C. P. Gillette, of the Agricultural Experiment Station at Fort Collins, Colo., was also in the field investigating rumors, and, in fact, it may be stated that all of the experiment stations were fully alive to the importance of the work.

By the end of July, from the reports of agents, I was satisfied that while a number of species of local nonmigratory locusts had multiplied far beyond the normal point and had undoubtedly done more or less damage, and while swarms and isolated individuals of the true Rocky Mountain locust had appeared in a few cases, the reports as a whole had been greatly exaggerated, and fears had been aroused which, while they were not to be wondered at in view of the recollection which must ever exist in the minds of the farmers of Kansas, Colorado, and adjoining States of the dark days of 1874, 1875, and 1876, were nevertheless to a great extent unfounded.

EASTERN COLORADO.

The first point visited by Mr. Bruner was Lincoln County, Colo., where he arrived at the northern boundary of the infested territory at the time when Prof. Popenoe and Prof. Snow were conducting their investigation at the southern boundary. Here he found a strip of country comprising nearly 500 square miles overrun by a locust known as *Dissosteira longipennis*. This is a local species always occurring over the higher portions of the plains lying on the eastward of the Rocky Mountains in the States of Wyoming, Colorado, and New Mexico. Throughout the infested region the locust occurred in great numbers, and was materially injuring the grasses growing upon the ranges. Little injury was done to the cultivated crops, although, as pointed out by Prof. Popenoe in some remarks made before the meeting of the Association of Economic Entomologists in Washington, in August, the damage done by all sorts of insects was attributed to locusts. He observed them marching through fields of potatoes and corn in great numbers, but without injuring these crops. Upon inquiry Mr. Bruner found that the insects had come into that country the previous fall and had laid their eggs over a very large area. The present season, when the eggs hatched, the young locusts began to move from their breeding centers in all directions, seeking open places and the edges of plowed fields and following the roadways, along which they move quite rapidly, traveling about 7 miles in six hours, but only for six or eight hours a day. This peculiarity is explained by Mr. Bruner by the fact that this species normally frequents partially bare hill slopes and plains where the grasses are scant, and that the past few years have been particularly favorable to its successful multiplication. During the present year, however, the exceptionally heavy rains which have occurred in that region have caused an unusually abundant growth of grasses and other vegetation, and the locusts have therefore moved in search of more normal conditions and have frequented the roads, upon which they congregated and which they followed in vast bodies. This view was supported by the fact that upon leaving the road and going for some distance into the

ranges where the vegetation was at all rank very few locusts could be found. This peculiar habit was well calculated to cause popular alarm, and it is quite likely that had the same body of insects been scattered through the rank grasses of the prairies they would hardly have attracted attention.

This species in size and length of wing much more closely resembles the migratory and destructive species of Europe and some other countries than the Rocky Mountain locust, and there seems to be no particular reason why at times it should not become destructive and fly in vast swarms from one locality to another. The present year, in fact, Messrs. Popenoe and Snow observed them flying southward with such ease, by reason of their long wings, that they resembled birds. So far as past experience justifies calculation, however, there is little reason to fear long-continued and widespread injury from this species.

It is a matter of great interest in connection with this species that its concentration in injurious swarms is due to conditions which are precisely opposite to those which favor the undue increase of the Rocky Mountain locust.

IDAHO.

During August, 1890, we sent Mr. Lawrence Bruner to Idaho to investigate the local outbreak of locusts in that State. His report is published on pages 135–141 of Vol. III, Insect Life, and we have referred to this outbreak on page 262 of our last annual report. The species doing the damage was found to be *Camnula pellucida*. Five years ago this species was first noticed in considerable numbers in the center of the Camas prairie, near the town of Soldier. With each successive year since, the plague has increased and has spread over more territory. At first the locusts occupied in numbers only a few square miles, and did but little damage. The next year they became much more numerous, and began moving outwards in various directions from this center, damaging grasses and grain and other cultivated crops growing upon the sparsely cultivated fields. At this time the pest could have been exterminated readily by a few intelligent and energetic farmers. After the third year the settlers began to be discouraged, but just before egg-laying time the locusts are said to have left the low land in the valleys for the foothills adjoining, where they laid their eggs. As most of them moved in a northeasterly direction, new hopes were aroused, and the settlers believed that they were leaving for good. But the following spring, after a very hard winter and very deep snow, the locusts began hatching on the hillsides, and, acquiring wings, flew down into the valley upon the fields of grain and gardens, which they stripped in a very short time. When all cultivated plants had disappeared the native grasses were attacked and devoured. This was the season of 1890, and when Mr. Bruner arrived, in August, a strip of country, commencing at a point 30 miles to the westward of Soldier, Logan County, and extending as far to the westward as Lost River and Birch Creek, was occupied. It was a strip of about 30 by 50 miles in width and about 140 miles in length. The place of greatest abundance appeared to be the region usually called the Camas Prairie, on the Malade River, and the valley of Wood River below Halley. The country by this time was measurably shorn of its vegetation, and the locusts had begun to oviposit. Instead of leaving the valley for the hills, as they had done in 1889, they oviposited in the valley, choosing gravelly and somewhat sandy places. Many diseased and parasitized

specimens were found, and the whole country was overrun by young toads, which promised to devour the young locusts in 1891.

Mr. Bruner expressed himself as of the opinion that the local plague was then at about its height, and while subsequent events show that he was measurably correct, it is unfortunate that, on the strength of this opinion, most of the farmers decided that there was no further necessity for fighting the plague, although it must be frankly stated that they had not done so previously and were not likely to do so in any event. The winter of 1890–'91 was comparatively mild, although spring was slow in coming and heavy rains continued during May, June, and the first part of July. The young locusts upon hatching began to move slowly toward the lower end of the valley. Fortunately the vast armies, which were thus gradually formed, met, before very long, owing to a felicitous conformation of the country, with the Malade River and its tributaries, were unable to cross, and, increasing rapidly from daily reinforcements, devoured the neighboring vegetation and perished from starvation. Some of Mr. Bruner's informers, however, claimed that they became diseased and died in vast numbers in consequence. The bodies of great hosts were washed away by the streams and piled upon the banks in heaps, remnants of which were seen as late as the 10th of September. In spite of this great destruction, enough locusts were left to damage grain and grasses in the valley more than in 1890. None of the farmers harvested full crops. Upon obtaining their wings the insects flew off towards the hills, most of them to the eastward, but others to the south and southwest, while a few remained in the hills and mountains to the north of the prairie. It is the opinion of the ranchers that but few eggs were laid in the prairie proper, and Mr. Bruner was not able to find many. Still there may have been quantities in districts not visited.

As a result of the abundance of this species in the same region for several years in succession, the natural enemies have increased considerably, and while they did not make much of an impression this year, still, owing to the probable lessening of the numbers of the locusts another season, they will doubtless have a marked effect. The natural enemies noticed by Mr. Bruner are the locust egg mite, several Tachina flies, several robber-flies (Asilidæ), several ground beetles, two blister-beetles, and certain wasps. In addition to these, the streams of the region "were full of one or more species of hair worms," which had probably been parasitic within the bodies of locusts.

Thus the outlook next year from these particular locusts is more hopeful, but Mr. Bruner reports that there has been a decided increase of the lesser migratory locust (*Caloptenus atlanis*), the detestable locust (*C. fœdus*), the two-striped locust (*C. bivittatus*), and *Pezotettix enigma.* All of these were quite plentiful at various points, and in some localities materially damaged the grasses. It seems likely that the abundance of natural enemies will have a depressing effect upon these species as well as upon the offspring of the survivors of the host of *Camnula pellucida.*

THE RED RIVER VALLEY OF NORTH DAKOTA, MINNESOTA, AND MANITOBA.

Thorough and careful search through the northern section of Mr. Bruner's journey convinced him that there were no migratory locusts of any consequence in the country west of Devil's Lake, North Dakota. At a few points in the mountains of Montana very limited areas were found in which *Camnula pellucida* occurred in the valleys in hay fields.

In the Red River Valley of North Dakota, Minnesota, and Manitoba, however, the true Rocky Mountain locust (*Caloptenus spretus*) was found, and the lesser migratory locust (*C. atlanis*), the two-striped locust (*C. bivittatus*), and the pellucid locust (*Camnula pellucida*) were also found in injurious numbers. In the valley and for some distance back into the hills to the westward these species were all present in unusually large numbers. A journey as far north as Winnipeg showed that the region of undue increase extended into Manitoba. The locusts occurred in areas and were not generally spread over the entire region.

Inquiry showed that the Rocky Mountain locust entered North Dakota during the fall of 1890 from the northwest territory, flying in just to the east of Turtle Mountains and depositing the first batch of eggs near the town of Cando, Towner County. From this point they evidently passed eastward and a little to the south, leaving eggs at favorable points along the route. It is probable, according to Mr. Bruner, that these swarms were composed of individuals which had hatched in the spring in the vicinity of Regina, and which were reported to have disappeared in a southeasterly direction after becoming winged. In this event the Rocky Mountain locust is not abundant in any other localities in the United States or British America, so far as we know, and it therefore becomes a matter of the most vital importance that the most strenuous efforts should be made to stamp it out within its present limits. That the authorities of Minnesota and North Dakota are fully alive to the importance of this work may be safely stated, and we have only words of the heartiest approval for the enlightened activity which they have shown. We referred two years ago to the energetic manner with which the Minnesota people supported Prof. Lugger in his work against the isolated swarms which had settled in Otter Tail County, and the present incursion has been met in the same spirit. Over 200 hopperdozers were put at work, and from 8,000 to 10,000 bushels of locusts were destroyed and large numbers of eggs were destroyed by plowing under before hatching. It is calculated that 20,000 acres of wheat were saved the present season alone, and the probable after-saving from the losses which would doubtless have followed had this work been left undone is almost beyond computation.

We may therefore feel reasonably sure that these two States, working for their own good, will destroy the offspring of these swarms so thoroughly that adjoining States need have no fears. Regarding the danger from the British possessions, where no work seems to have been done, we feel less assured. Mr. Bruner on his journey could make only a short trip into Manitoba. We endeavored to make some arrangement with the Canadian authorities to have the Dominion entomologist, Mr. James Fletcher, sent along the border line in the early fall, but from the fact that that region had just been visited by the director of the Experimental Farm System of Canada, Mr. William Saunders, who, although traveling with a different object in view, had heard nothing of locust damage, it was considered unnecessary to go to the expense. Mr. Saunders is an entomologist of note, and his statement is undoubtedly exact as far as it goes. But the fact remains that Mr. Bruner in August found the locusts unduly multiplied in Manitoba, and there is still some reason for apprehension lest a sufficient number of eggs may have been deposited in that province to develop a swarm of injurious numbers next fall. If so, however, the Canadian authorities will probably take hold of the matter the coming summer and undertake the necessary remedial work.

KANSAS.

A region of considerable extent in southwestern Kansas was overrun by large numbers of the large yellow locust (*Caloptenus differentialis*), and the two-striped locust (*C. bivittatus*) was also present in unusual numbers. Alfalfa fields were damaged to considerable extent, sorghum and oats were injured, and orchard trees in some cases were damaged, the leaves of the latter having been eaten off and the bark gnawed. The injured territory, which was investigated by our agent, Prof. Osborn, as before stated, is said by him to coincide with the irrigated portion of the Arkansas Valley lying in Finney, Kearney, and Hamilton counties, in southwest Kansas. Some fields are much less damaged than others, and the whole area extends with occasional breaks to a distance of about 50 miles along the Arkansas River, forming a strip of from one to five miles wide. The greatest damage was observed near Garden City. According to Prof. Osborn's observations, it seems probable that the oviposition will be confined largely to the immediate vicinity of the irrigating ditches, and he, therefore, advised that the surface of the ground in and along the ditches should be thoroughly broken up before winter by thorough harrowing, cultivating, or shallow plowing, and also that the ground should be flooded, wherever practicable, for a day or two at a time while the young locusts were hatching. This plan of treatment, together with the use of hopperdozers, meets with our approval, and if it has been and will be followed this winter and next spring much good will be accomplished. Many parasites were noticed, and it is probable that they will prove an efficient help in reducing the numbers another year.

TEXAS, NEW MEXICO, AND ARIZONA.

The newspaper reports from these localities have undoubtedly been greatly exaggerated. Mr. Banks, on his trip, was unable to find any region of actual damage, although locusts of local species were rather more than normally abundant in some neighborhoods. Some damage was done to vineyards and certain shrubs and trees by *Acridium shoshone* and *Caloptenus differentialis* in New Mexico, but no marked damage can well have been done in any of these States without our knowledge under the circumstances.

CALIFORNIA.

The reports from California were thoroughly investigated by Mr. Coquillett, the agent located at Los Angeles, Cal. He visited all parts of the State from which locusts were reported, and found that considerable damage had been done by the California devastating locust (*Caloptenus devastator*), and that several other species, such as the red-winged locust (*Oedipoda venusta*), the pellucid locust (*Camnula pellucida*), *Dissosteira spurcata*, and *Trimerotropis pseudofasciata*, were more than usually abundant. The region of country which suffered most from the ravages of the devastating locust during 1891 is comprised in the three counties of Placer, Sacramento, and San Joaquin. It was also present, however, in portions of Kern, Yuba, Sutter, Shasta, and a few other counties, although in smaller numbers. In certain portions of the three counties first mentioned it was reported by several observers that the locusts came from the eastward in great swarms at intervals of about two weeks, and, from Mr. Coquillett's observations, it seemed reasonably certain that these swarms hatched out in the open

pasture lands among the foothills in the eastern part of Sacramento County, and also in the western portion of El Dorado, Amador, and Calaveras counties. A most interesting point has been derived from his observations, to the effect that the young locusts occur most abundantly and, in fact, almost exclusively, among patches of the common weed known as the "tarweed" (*Hemizonia virgata*), in the eastern portion of San Joaquin and Sacramento counties, and also in portions of Calaveras and El Dorado counties. It was rare to find a patch of these weeds in which the young of these locusts were not present in greater or less numbers, and, at the same time, it was extremely rare to find the young in places where none of these weeds grew. North of Sacramento, in Yuba, Butte, and Tehama counties, this "tarweed" is replaced by another, known as *Layia glandulosa*, a low-growing, viscid, loosely branched annual composite. This plant, also, was nearly always accompanied by the young as well as by the adults of the California locust, which were not found except where the weed grew. No locusts were found in the act of ovipositing, but, from the facts above detailed, it is reasonably certain that they prefer patches of these two weeds in which to breed. Mr. Coquillett paid considerable attention to the natural enemies, and reports in full upon them.

In a number of localities where the locusts appeared in ordinary numbers they were readily destroyed by means of the bran-arsenic mash described in our annual report for 1885, and which we have particularly mentioned in Bulletin No. 25 of this division. This remedy, where properly mixed, seems everywhere to have been successful. Spraying orchard trees with Paris green and water was also tried, but proved an apparent failure in the majority of cases. The most feasible method of treating this species, however, in the future, will come from our greater knowledge of its breeding habits, by using the mash, and the use of the plowing or burning-over methods in the breeding localities, which, if Mr. Coquillett's surmises are correct, are not only of more or less limited extent, but are readily recognizable from the character of their vegetation.

INSECTICIDES.

Much, whether good, bad, or indifferent, has been published concerning the almost endless number of substances which have, or are supposed to have, insecticide properties.

I shall notice here what in practice have been found to be the more important remedial agents.

A true theory of the application of insecticides must rest upon known facts in the development and economy of the insects to be dealt with. This statement does not mean that every species must be treated with remedial measures peculiar to itself. On the contrary, many species have similar habits and may be similarly dealt with, and in general all insects, in their relation to remedies, come under two categories, viz, the mandibulate species, which devour the solid substances of the plant, and which may be destroyed by applying poisons to their food, and the haustellate species, which by means of a sucking beak extract the juices of the plant tissues, and which may be controlled by applying caustic or oily substances to the insects themselves.

It is convenient, therefore, to divide insecticides into two classes, viz, those which are food poisons and those which kill by contact with the insects. Under these two heads I will briefly notice those of most importance.

FOOD POISONS.

There are many substances which destroy when applied to the food of insects, but of these only one is commonly in use, viz, arsenic. This is a well-known mineral poison and is used in three forms, (1) the crude white arsenic (arsenious oxide), (2) Paris green (arsenite of copper), and (3) London purple (calcium arsenite in part).

White arsenic.—This is much the cheapest of the three forms, and can be procured from druggists in a fine white powder of heavy specific gravity or in amorphous solid masses. The powder form is the only one with which we are here concerned. It varies in solubility according to physical conditions, but it is soluble in fifteen parts of boiling water after long ebullition. On cooling a portion is precipitated, about 1 part to 45 of water remaining in solution. In this condition it exerts a caustic burning effect upon all tender foliage, and can scarcely be used with safety if strong enough to be insecticidal. If freshly mixed, however, in cold well water, as shown by Mr. C. P. Gillette* it may be applied with safety at a considerable strength even to tender foliage of the peach and plum. The immunity from scalding comes from the fact that it is so slightly soluble under these conditions. Because of its heavy specific gravity it can not be successfully used in liquids in suspension, and aside from these drawbacks a strong objection is found in its color, which renders it liable to be mistaken for other harmless white substances.

Paris green.—This now well-known insecticide is a green pigment which has long been used in the arts, though the commercial article now so commonly sold as an insecticide is often adulterated. It is prepared by precipitating a caustic solution of arsenic with a solution of sulphate of copper, the resultant powder being in as fine a state of divisibility as possible. This adds to its advantages over the form of arsenic previously mentioned for using in water suspension, but its specific gravity is also great and renders it difficult to keep in suspension. However, it has long been successfully used in suspension liquids and also in dry mixtures. It is but slightly soluble in water; nor is it desirable in an arsenical insecticide that it should be soluble in water, as in solution it reverts to arsenious acid and is more or less injurious to foliage according to the strength of the preparation used. Arsenical preparations are best put upon foliage in a practically insoluble but finely divided state for insecticide purposes.

London purple.—This is a cheap and convenient preparation of arsenic, and is now largely used in place of Paris green. It is a refuse product in the manufacture of rose-aniline dye. It is not a pure product of definite composition, but contains calcium, arsenious oxide, and some impurities. It is obtained by precipitation, and after being dried is ground and bolted, when it is ready for use. The statement is generally made that it is in a finer mechanical condition than Paris green, but this is not always true. This powder is of such light specific gravity that it is especially desirable for suspension liquids. If properly mixed it will remain in suspension for several hours with but slight precipitation.

These poisons are of the greatest service against all mandibulate insects, as larvæ and beetles, and they furnish the most satisfactory means of controlling most leaf-feeders, and the best wholesale remedy against the codling-moth. Caution must be used in applying them on account of the liability of burning or scalding the foliage.

The poisons should be thoroughly mixed with water at the rate of

*Bulletin 10, Iowa Experiment Station, August, 1890.

from 1 pound to 100 to 250 gallons of water, and applied with a force pump and spray nozzle. In preparing the wash it will be best to first mix the poison with a small quantity of water, making a thick batter, and then dilute the latter and add to the reservoir or spray tank, mixing the whole thoroughly. When freshly mixed either London purple or Paris green may be applied to apple, plum, and other fruit trees, except the peach, at the rate of 1 pound to 150 to 200 gallons, the latter amount being recommended for the plum, which is somewhat more susceptible to scalding than the apple. White arsenic does little if any injury at the rate of 1 pound to 50 gallons of water. As shown by Mr. Gillette (*loc. cit.*), however, when allowed to remain for some time (two weeks or more) in water, the white arsenic acts with wonderful energy, scalding, when used at the rate of 1 pound to 100 gallons, from 10 to 90 per cent of the foliage. The action of the other arsenites remains practically the same, with perhaps a slight increase in the case of London purple.

With the peach these poisons, particularly London purple, when applied alone, even at the rate of 1 pound to 300 or more gallons of water, are injurious in their action, causing the loss of much of the foliage.

Mr. Gillette has shown (*loc. cit.*) that by the addition of a little lime or the Bordeaux mixture, which contains lime, London purple or Paris green may be safely applied, at the rate of 1 pound to 125 to 150 gallons of water, to the peach or the tenderest foliage, or in much greater strength to strong foliage, such as that of the apple or most shade trees. Whenever, therefore, the application is made to tender foliage, or when the treating with a strong mixture is desirable, lime water, milky but not heavy enough to clog the nozzle, should be added at the rate of about 2 gallons to 100 gallons of the poison.

As has already been intimated, the scalding resulting from application of these poisons arises from their being more or less soluble. In a finely divided state they do no injury to the plant. The lime serves to precipitate, as insoluble arsenite of lime, the arsenic in solution, more or less of which will occur, particularly in the case of white arsenic which has been in water for a time and to a less extent with London purple, and still less with Paris green, and prevents by this means the scalding of the foliage without apparently limiting the value of the insecticide.

The success experienced in combining arsenicals with the Bordeaux mixture led Mr. Gillette to experiment with combinations of arsenicals with other fungicides. The results in the case of the carbonate of copper solution with arsenicals were indeterminate, but with London purple combined with sulphate of copper solution, the scalding was vastly more than with the arsenites alone, indicating that the combination had resulted in very considerably increasing the amount of soluble arsenic.

Combining the arsenites with other insecticides was also tried, with the result that in connection with soap mixtures and kerosene emulsion the scalding action was greatly increased, but with the resin washes no increased action appeared to result. It was found also that combining the arsenites with flour paste, as has been commonly advised, to secure more uniform mixtures and to cause the poison to adhere better to foliage, also considerably increased the action of the poison, and is not to be recommended.

Mr. B. W. Kilgore, first assistant chemist of the North Carolina Agricultural Experiment Station, from a careful series of analyses and

experiments prosecuted in the summer of 1890, but not published until July, 1891,* arrives at conclusions almost identical with those reached by Mr. Gillette, and gives data obtained from careful analyses, showing the relation of solubility of arsenites to the scalding. The important additional facts brought out by Mr. Kilgore are that while London purple and Paris green may be applied to foliage with safety almost immediately after mixing with lime (the soluble arsenic being almost immediately changed by the lime into insoluble arsenite of lime) the white arsenic, on the contrary, can not safely be applied for several days, considerable time being necessary for the complete change to insoluble arsenite.

He found also that the action in this regard could be greatly hastened by treating the white arsenic and lime together for a short time with boiling water, giving a very cheap insecticide, having the same properties as London purple, and has furnished the following formula for preparing this arsenite for use:

Boil together for one-half hour in 2 to 5 gallons of water 1 pound commercial white arsenic and 2 pounds commercial lime, and dilute to required volume, say 100 gallons. The white arsenic can be obtained in quantities of 10 pounds for 8 to 12 cents per pound. Cost of lime will add very little to this. It is desirable that the lime should be present in the boiling solution of white arsenic, since it renders the latter insoluble as fast as it goes into solution, thus reducing the volume of water and shortening the time for obtaining the arsenite. When the white arsenic is dissolved alone a larger volume of water and more time are required. When lime is added the precipitation goes on slowly, requiring more than twenty-four hours to reach completion.

Mr. C. W. Woodworth, at that time entomologist of the Arkansas Experiment Station, gives † a record of a careful series of experiments which demonstrate the same facts as to the effect on foliage of the three arsenicals mentioned, but was evidently unaware of the effect of the addition of lime.

The practical value of facts resulting from the work of Messrs. Gillette, Kilgore, and Woodworth in the direction indicated are very great, since they give a better understanding of the cause of the scalding effects produced by the arsenicals, which previously had been a matter rather of supposition than of positive knowledge, and enables us by the use of lime to employ with safety much stronger mixtures than was previously possible.

With the apple, in spraying for the codling-moth, at least two applications should be made, the first on the falling of the blossoms, the apples being about the size of peas, and the second a week or ten days later; but the poison should never be applied after the fruit turns down on the stem, on account of the danger of the poison collecting and remaining permanently in the stem cavity.

For the plum curculio, on the plum, cherry, peach, etc., two or three applications should be made during the latter part of May and the first half of June; in the case of most leaf-feeders, spray on the first indication of their presence.

CAUTION NECESSARY IN THE USE OF THESE INSECTICIDES.

The relative susceptibility of the apple, plum, and peach has just been indicated under the head of arsenical poisons, and these remarks apply

* Technical Bulletin 2, North Carolina Agricultural Experiment Station, Bulletin No. 77b, July 1, 1891.

† Bulletin 14, Arkansas Experiment Station, September 1890.

equally well to the use of the kerosene emulsions. In the case of other plants thorough experiments are still necessary, and all insecticides should be first used in comparatively high dilution. In general, it may be said that thin-leaved pilose plants are more readily injured, while thick-leaved glabrous species are least affected. Annual plants, such as cabbages and other garden vegetables, are more susceptible than perennials, but in the case of root crops, such as beets, turnips, radishes, and potatoes, there is not the same need of caution as to damage to foliage. The experience of Messrs. Gillette and Woodworth and also of Prof. Bailey, of Cornell, would indicate that, contrary to a prevalent opinion, young foliage is less susceptible to scalding than mature foliage, particularly in late fall application, the newly expanded leaves being protected in a manner by a waxy covering, as stated by Prof. Bailey.

Mr. Gillette finds also that heavy dashing rains lessen the amount of scalding by washing the poison from the leaves, while very light rains, heavy dews, or moist weather increase the action by furnishing the moisture necessary to dissolve the arsenic. The time of the application, whether in bright sunshine or in cloudy weather, appears to exert no influence. Damage to foliage is not shown at once, and in case of light rain following an application, another application should not be made for several days.

An important source of damage comes from bad spraying, which permits the poison to accumulate and settle on particular parts of the foliage treated, and a consideration of the utmost importance is that the poisoned liquid should be lightly and evenly distributed.

Another point which should not be lost sight of is that spraying fruit trees while in blossom is liable to poison honeybees by the wholesale.

Dry mixtures.—The arsenicals in dry preparations have been much used, but where they can be conveniently used in liquid form this last method has many advantages. The early use of Paris green was principally in dry mixtures, and for some time 1 pound of the green to 20 or 25 of the diluent was a standard preparation. This proportion is unnecessarily strong. One pound to 50 of the diluent is sufficient, and if properly mixed and applied with care it can be made considerably weaker for many cases. Some advocate its use in as weak a mixture as 1 pound to 100 of diluent, and even weaker. For diluents poor grades of flour, dry-slaked lime, ground gypsum, etc., are used. A very important consideration in this connection is that the specific gravity of these diluents varies so that a formula stated in pounds gives no relative idea of the bulk of diluent. Gypsum is more than twice as heavy as the same bulk of flour or dry-slaked lime. The dilution mentioned above is on the basis of using flour; hence with gypsum 1 pound to 100 would not be too weak a mixture if thoroughly applied.

Aside from the mineral poisons just noticed, the following poison has quite an extensive use for a limited number of species:

White hellebore.—This substance, which is the powdered root of *Veratrum album*, is the almost universal remedy for the currant worm and other allied sawfly larvæ. It is grayish white powder, and if well prepared can be used through a spray nozzle. It has heretofore been used mostly in the dry state, but recent experience is decidedly in favor of water suspensions. One ounce incorporated with a small quantity of water and then diluted to 1 gallon makes a preparation of ordinary strength. This sprayed forcibly upon the foliage of currant and gooseberry bushes will soon clear them of larvæ.

In the dry state it is used pure and also diluted. If good powder is

used it will be strong enough when diluted with an equal bulk of flour. In this condition its application is best accomplished with a powder bellows. It should be applied when the foliage is damp. The wet application requires much less powder, and can be made at any time to suit the convenience of the operator.

INSECTICIDES WHICH DESTROY BY DIRECT CONTACT.

There are several substances which are commonly used as external applications to destroy insects where arsenical poisons can not safely be used and for those species which do not eat the foliage. Some simple application like ashes, lime, road dust, etc., are often successfully used where they can be brought into contact with soft-bodied larvæ, or species which are sensitive or easily disturbed, the result being to kill or drive them away. The better known remedies of this sort which have positive effects are here mentioned.

Alkaline washes.—These are among the simpler remedies of this class, and are very effective for such insects as plant-lice and scale-insects. However, among these two families of the Homoptera there is such a difference of habit and such wide individual peculiarities that no general direction for treatment can be given. Most plant-lice succumb readily to treatment; hence a weak preparation of potash or soda lye will destroy them. Usually a 2° to 5° Baumé solution is sufficient. The strength of different brands of concentrated lye is so variable that general directions are not very reliable, but one ordinary can is usually sufficient for 8 to 10 gallons of water. For treating most of the scale insects it is necessary to use a strong solution, 25° to 30° Baumé. This strength is almost sure to injure the plant, and in the light of experience I can not advise its use.

The use of alkaline washes themselves, *i. e.*, without any other ingredient, is not, as a rule, satisfactory. Though the strength may be all that is required, the desired end is not accomplished. This is especially true where the wash is sprayed on foliage to destroy plant-lice. It has been found that making a soap wash overcomes this difficulty and really adds to the efficacy of the preparation, and, at the same time, cheapens it. A cheap soap can be made from fish oil so as not to cost more than 1 or 2 cents per pound, and 1 pound of this is quite sufficient for 4 gallons of wash for plant-lice. It should be used when fresh. This wash would be of no avail against bark-lice, except for the young. Any cheap soap preparation can be successfully used to destroy plant-lice. The increased value of the saponified wash rests both in its oiliness and alkalinity, and, further, in the adhesive spreading character which it acquires. The application of this, like other washes, to get the best results, should be in a strong spray. In general, it may be said that the practical application of alkaline washes is limited to plant-lice and the younger stages of bark-lice.

The kerosene emulsions.—These are preparations which were first devised in my work for the Government, and where intelligently used and adapted to the requirements of the species to be treated they have steadily grown in favor. Among experts in the use of insecticides they stand decidedly at the head of washes for external application. They are not as simple in preparation as the alkaline washes, and there is, in careless hands, more danger of injury to plants. But reasonable intelligence and a little experience in preparation and application are all that is necessary for their successful use. When an emulsion is once prepared its dilution and use is as easy as that of soap suds.

The formula which long experience in the Government work has shown to be the best is, stated with reasonable exactness, kerosene, 66 per cent; strong soap suds or sour milk, 34 per cent.

The milk formula is an outgrowth of a large series of experiments, conducted by myself or under my direction by Dr. Barnard during the work of the Entomological Commission, with the cotton-worm, and is in the matter of ease in the mixing of ingredients superior to the soap emulsion, the formula for which was determined experimentally by Mr. H. G. Hubbard while acting as an agent of the division.

Many more formulas have been prepared for the use of kerosene in water, but from exhaustive tests this has proved the best, and though other formulas are still published by writers on economic entomology, none of them make such a perfect emulsion, while some of them are misleading, and based on misapprehension of what constitutes an emult sion. The destructive ingredient is the kerosene, and the end sough- is to use it as safely and as economically as possible without unnecessary complication with other materials.

The formula above given for the soap emulsion, stated in convenient quantities of the ingredients, is as follows:

Kerosene	gallons..	2
Water	do...	1
Soap (whale oil)	pound..	½

The soap is dissolved in the water, brought to boiling heat, removed from the fire, and the kerosene added; then churned rapidly by pumping it back upon itself with a force-pump until the emulsification is perfect. This will not require over five minutes. The mixture swells considerably during this operation, and when the emulsion is complete it will adhere to the surface of glass without oiliness. This is the standard emulsion. The quantity of soap may be varied, and also the percentage of oil, but these proportions have been experimentally determined to work well in practice, and can be relied upon to give an admirable preparation.

Recent experimentation has demonstrated, however, that in limestone regions, in which the water is strongly impregnated with lime or magnesia, there may be more or less separation of free oil on dilution, depending upon the percentage of the lime or magnesia in the water. If such result takes place it can be obviated by either using rain water or by breaking the hard water before using with lye or bicarbonate of soda.

The slight separation of the oil with hard water is induced by the chemical action of the lime and magnesia salts on the soap, resulting in the formation of insoluble oleate, palmitate, or stearate of lime or magnesia, and the consequent freeing of the oil which was held by this soap in the form of an emulsion.

In the case of the milk emulsion no separation of the free oil will occur no matter how hard the water, simply because there is no soap present and no chemical action takes place; and for this reason in hard-water regions, which will include more or less of the northern Mississippi Valley, the milk formula is to be preferred.

The emulsion with milk is made according to the following formula:

	Gallons.
Kerosene	2
Milk (sour)	1

Heating is not necessary in the making of this emulsion, which otherwise is made after the method employed with the soap formula. The

resulting product is somewhat thicker than with soap, and the change from a watery liquid to a thick buttery cream is very sudden.

With absolutely sweet milk difficulty will frequently be experienced in producing an emulsion, but a dash of vinegar or acid will insure prompt action. The degree of sourness exerts little effect; milk just turning, or clabber, will give equally satisfactory results.

As before stated, the application is simple, the emulsion needing only to be diluted in water according to requirement, and applied in spray. It is quite adhesive and spreads well over the surface of leaves. The proportions to use on different plants and for different insects have been measurably determined, and may be generally stated as follows: On ordinary tender plants it can be safely used diluted with twenty-five to thirty times its bulk of water. This strength will, under most circumstances, kill all plant-lice. For bark-lice it must be used stronger. On orange trees the armored scales (*Diaspinæ*) have been quite successfully killed with a preparation diluted nine times with water, while the naked forms are killed by a weaker solution. The orange tree, under favorable circumstances, will withstand uninjured an even stronger application than that for armored scales. Peach trees, which are very sensitive to arsenical preparations, are not injuriously affected by the emulsion diluted five times during the dormant season, while a strength of 1 part emulsion to 2 of water can be used upon them at this time without much damage if the tenacity of the scale demands it. Such applications as the last should always be made before blooming or after bearing, as the tender foliage would be injured, and, if in bearing, the crop would be damaged.

Hardy rosebushes are scarcely injured by the application of 1 part emulsion to 5 of water, and are perfectly safe with 1 part to 10. Soft maples treated for scale-insects have withstood with but slight injury a strength of 1 part emulsion to 5 parts of water. When trees are in the dormant state they will bear much stronger applications without harm than when rapidly growing.

For subterranean larvæ the kerosene emulsion has been tried in the work of the division with considerable success. The experiments have been principally for such insects as affect the roots of cabbage, radishes, and other cruciferous plants; also for larvæ affecting the roots of squashes, for the grape phylloxera, and the white grubs (*Lachnosterna* and *Allorhina* spp.). Its successful use on these last is recorded in Insect Life, Vol. I, No. 2 (pp. 48–49). Its great value against the Phylloxera was conclusively shown in a series of experiments made in 1883, in which it was found to not only destroy the insect in all stages, but also to stimulate root growth. For this purpose it is applied in the same manner as the resin washes described below.

For use in the ground the strength may be greater with less risk of injury than for use on the stems and foliage of plants; but little is gained by strong preparations, as a large amount of larvæ are so tender that contact with a small particle of the oil destroys them. Generally, preparations diluted ten to fifteen times are efficacious if used abundantly. Drenching the soil with water will aid in carrying the emulsion down.

Kerosene emulsion and pyrethrum.—Experiments by C. P. Gillette, Albert E. Menke, assisted by G. C. Davis and Jerome McNeill, have indicated that pyrethrum can either as an aqueous or kerosene extract be added to the kerosene emulsion with advantage in the work against certain insects. Mr. Gillette says (Insect Life Vol. III, p. 260):

The combinations were made by mixing the dry pyrethrum into a previously prepared kerosene emulsion, by using pyrethrum tea instead of pure water to dilute

the emulsion, and by extracting the powdered pyrethrum with kerosene and then emulsifying this extract. I have used such an emulsion in comparison with an ordinary kerosene emulsion for the destruction of the chinch-bug, the false chinch-bug, *Nysius angustatus*, the red spider, plant-lice, and cabbage-worms, and it has been very uniformly more successful than the latter, but it will be necessary to experiment further before drawing definite conclusions as to the real value of the compound for the destruction of insects.

The proportions used by Messrs. Menke and Davis are 2½ pounds of pyrethrum to 1½ gallons of kerosene, which is then emulsified with soap and water. One part of the resultant emulsion to 450 or 500 parts of water is said to be effectual. At a strength of 500 to 900 parts of water to 1 of the emulsion the half grown and smaller worms "seldom escape death." The application of 1 part to 500 of water causes the worms to die in from twelve hours to two days, according to size. This mixture will kill pupæ when any opening in the loose cocoon allows them to become wet. It is an extremely cheap mixture, and according to the formula given by Mr. Davis, cotton fields can be sprayed at an expense of 5 cents per acre for material.

In spite of Mr. Menke's claims to priority for the discovery of this extract, Prof. C. P. Gillette was the first to give it public mention,* though his method of preparing it may differ in detail from that of Mr. Menke. Prof. Jerome McNeill, one of our temporary agents, writes us, however, that the idea of using the combination of these two substances was given to Dr. Menke by him, in conversation soon after the latter's appointment as an agent of this division, Prof. McNeill proposing to experiment with this combination upon the boll-worms.

The resin washes.—These insecticides act by contact, and also, in the case of scale-insects, by forming an impervious coating which effectually smothers the insects treated. The resin washes vary in efficacy according to the insect treated. The later experience of our California agent, Mr. Coquillett, has shown that the best formula for the red scale (*Aonidia aurantii* Maskell) and its yellow variety (*A citrinus* Coquillett) is as follows:

Resin	pounds	18
Caustic soda (70 per cent strength)	do	5
Fish oil	pints	2½
Water to make	gallons	100

The necessary ingredients are placed in a kettle, and a sufficient quantity of cold water added to cover them; they are then boiled until dissolved, being occasionally stirred in the meantime, and after the materials are dissolved the boiling should be continued for about an hour, and a considerable degree of heat should be employed so as to keep the preparation in a brisk state of ebullition, cold water being added in small quantities whenever there are indications of the preparation boiling over. Too much cold water, however, should not be added at one time, or the boiling process will be arrested and thereby delayed, but by a little practice the operator will learn how much water to add so as to keep the preparation boiling actively. Stirring the preparation is quite unnecessary during this stage of the work. When boiled sufficiently it will assimilate perfectly with water, and should then be diluted with the proper quantity of cold water, adding it slowly at first and stirring occasionally during the process. The undiluted preparation is pale yellowish in color, but by the addition of water it becomes a very dark brown. Before being sprayed on the trees it should be strained through a fine wire sieve or through a piece of Swiss muslin, and this is usually accomplished when pouring the liquid into the spraying tank

* Bulletin No. 5, Iowa Experiment Station, May, 1889, p. 184.

by means of a strainer placed over the opening through which the preparation is introduced into the tank.

The preparation of this compound will be greatly accelerated if the resin and caustic soda are first pulverized before being placed in the boiler, but this is quite a difficult task to perform. Both of these substances are put up in large cakes for the wholesale trade, the resin being in wooden barrels, each barrel containing a single cake weighing about 375 pounds, while the caustic soda is put up in iron drums containing a single cake each, weighing about 800 pounds. The soda is the most difficult to dissolve, but this could doubtless be obviated by first dissolving it in cold water and then using the solution as required. This insecticide may be applied at any time during the growing season.

A stronger wash is required for the San José scale (*Aspidiotus perniciosus* Comstock), and the following formula gives the best results:

Resin	pounds..	30
Caustic soda (70 per cent)	do	9
Fish oil	pints..	4½
Water enought to make	gallons..	100

Place all the ingredients in a kettle and cover with water to a depth of 4 or 5 inches; boil briskly for about two hours, or until the compound can be perfectly dissolved with water. When this stage is reached the kettle should be filled up with water, care being taken not to chill the wash by adding large quantities of cold water at once. It may be thus diluted to about 40 gallons, the additional water being added from time to time as it is used. This preparation should only be applied during winter or during the dormant period; applied in the growing season it will cause the loss of foliage and fruit.

In the application of both of these washes a very fine spray is not essential, as the object is not simply to wet the tree but to thoroughly coat it over with the compound, and this can be best accomplished by the use of a rather coarse spray, which can be thrown upon the tree with considerable force.

Recent experiments have shown the practical value of the resin compounds against the grape phylloxera, and they will also be applied to the apple root-louse and other underground insects. In this connection I have recently had a series of experiments made through Mr. Albert Koebele's agency in the Sonoma Valley, California, to ascertain the effect upon the phylloxera of certain of the resin washes which proved so valuable when used against the fluted scale and other scale-insects. The results have been quite encouraging, and the experiments have already shown that in the use of those washes we have a valuable addition to the underground remedies. Soaps were made by the use of bicarbonate of soda, salsoda, and caustic soda, each mixed with resin. In the earlier experiments the earth was removed about the base of the vine to a depth of 6 inches and for a diameter of 4 feet. Ten gallons of the mixture were poured into each hole and found to penetrate from 12 to 16 inches, or from 18 to 22 inches from the original surface of the ground. Most of the insects, as also the eggs, were destroyed to a depth of 16 inches. In the later experiments the holes were made only about 2 feet in diameter, and nearly, if not quite, the same results were obtained with half the amount, or 5 gallons of the mixture. The plan, which I have previously adopted for the application of insecticides to underground insects, of washing the mixture in with pure water was tried with good success. Soon after the first application 5 gallons of water were added, and 5 gallons more the following day. This would indicate that in the following spring, when rains are frequent (occurring

almost every day) in the Sonoma Valley, only a small amount of the mixture need be applied, and the rains will distribute it, as examination has shown that up to a certain point each application of water intensifies and extends the action of the original insecticide. The best soap was made with bicarbonate of soda, but the results of that made with caustic soda are so little inferior, while the price is so much less, that the caustic soap and resin soap mixture is the one which I would recommend. The formula which was found preferable is as follows:

Caustic soda (77 per cent)	pounds..	5
Resin	do....	40
Water to make	gallons..	50

The soda should be dissolved, over a fire, in 4 gallons of water; then the resin should be added and dissolved. After this the required water can be added slowly, while boiling, to make the 50 gallons of the compound. To this water may be added at the rate of 9 gallons for 1, making 500 gallons of the dilute compound, sufficient for 100 large vines, at a cost of only 84 cents, or less than a cent a vine.

Pyrethrum powder.—This name is applied in common to preparations of the flowers of several species of Pyrethrum. It is also known by several other common names, as Persian insect powder and Dalmatian insect powder. The best powder is manufactured from the flowers, but undoubtedly much of the powder which finds its way into commerce is adulterated by using other portions of the plant to some extent or by adding cheap adulterants, such as hellebore. The growing of one of the species (*Pyrethrum cinerariæfolium*) has of recent years become a quite extensive business in California. It is conducted at Stockton, in that State, by the Buhach Producing and Manufacturing Company. They call their product buhach, and it is, without question, one of the best brands of pyrethrum which can be obtained in this country. A full account of this industry is published in Bulletin No. 12 of this division. The powder must be kept in a closed vessel or its strength is gradually lost, and it is very apt to deteriorate with age. Its uses are limited, but for some purposes it is unsurpassed. One of its most important uses is for the imported cabbage-worms (*Pieris rapæ*). For these larvæ it is generally used dry, diluted three to five times its bulk with flour or any light diluent which will work well in a powder bellows. It adds somewhat to the efficacy of the mixture to let it stand some hours in a closed vessel before using. It is not effective on hairy larvæ, nor does it effectually destroy Aphids. If good powder is used it is almost a specific for bedbugs, fleas, house-flies, and mosquitoes.

This powder is often used in suspension with water for currant worms, rose slugs, etc., but I have found hellebore so much more effective that I much prefer to use it. Pyrethrum is nonpoisonous to the higher animals, but causes irritation of the mucous membranes if brought in contact with them. It is also irritating to the skin of some persons, especially of the more delicate or protected parts. Used in the dry way the diluted powder should be dusted on quite freely. In water suspension 1 ounce to the gallon of water is sufficient.

FERTILIZERS AS INSECTICIDES.

The importance of certain fertilizers as insecticides has been emphasized by the experiments of Prof. J. B. Smith in Bulletin No. 75 of the New Jersey Experiment Station. He has found the potash salts, preferably kainit, very effective against cutworms or wire-worms in corn. These salts have a high value as fertilizers, and stimulate the plant to renewed growth at the same time that they destroy the insects. Mr.

Smith recommends as the best method of application broadcasting in fertilizing quantity before or during a rain, so that the material is carried into the soil at once. In cornfields infested with the "white grub" or wire worms the application should be made before planting. In the case of strawberry beds infested with white grubs the application should be made at time of cultivation or before setting the plants.

THE GAS TREATMENT FOR SCALE-INSECTS.

Since the year 1887 various accounts* of this process of exterminating scale-insects have been published from time to time in the annual reports and bulletins of the Entomological Division of this Department. The latest complete account is given in Bulletin 23 by the agent having the direction of the experiments, Mr. Coquillett, and from it the summary of the process given below is taken. Briefly speaking, this process consists in covering the infested tree with an air-tight tent and afterward charging the tent with hydrocyanic-acid gas. The material commonly used in the construction of the tent is what is known as blue or brown drilling, which is much superior to the common ducking occasionally employed.

After the tent is sewed up it is given a coat of black paint, as it has been ascertained that tents treated in this manner last longer than those which have been simply oiled with linseed oil. Some persons mix a small quantity of soap suds with the paint in order to render the latter more pliable when dry, and therefore less liable to crack. Instead of thus painting the tent some persons simply give it a coating made of an inferior grade of glue, called "size," first dissolving this in water and then covering the tent with it, using a whitewash brush for this purpose. Sometimes a small quantity of whiting or chalk (carbonate of lime, $CaCo_3$) is added to this sizing with or without the addition of lampblack. A few make use of the mucilaginous juice of the common cactus (*Opuntia engelmanni* Samm.) for this purpose; to obtain this the cactus leaves or stems are cut or broken into pieces, thrown into a barrel, and covered with water, after which they are allowed to soak for three or four days; the liquid portion is then drawn off and is ready for use without further preparation. Tents which had been prepared with this substance were to all appearances as air-tight and pliable as when prepared in any other manner.

A tent 26 feet tall by 60 feet in circumference—a size large enough to cover the largest orange tree now growing in this State—if made out of drilling, and either painted or sized, as described above, will cost completed about $60. Where the trees to be treated are not more than 12 feet tall the tent can be placed over them by means of poles in the hands of three persons; to accomplish this three iron rings are sewed to the tent at equal distances around and 6 or 7 feet from the bottom of the tent; immediately under each of these rings an iron hook is attached to the lower edge of the tent. When the latter is to be placed over a tree each of the hooks is fastened into the corresponding ring above it; one end of the pole is then inserted into each of these rings, and the tent raised up and placed on the tree. The hooks are then released from the rings and the lower edge of the tent allowed to drop upon the ground. Instead of allowing the tent to rest directly on the tree some growers use an umbrella-like arrangement, the handle of which is in two pieces, which are fastened together with clamps provided with

*See Annual Report, United States Department of Agriculture, for the year 1887, pp. 123–142, and 1888, pp. 123–126. Also Insect Life, Vol. I, pp. 41, 42, and 286; Vol. II, pp. 202–207; Vol. III, pp. 457–460; Vol. IV, pp. 46, 47.

pins; this allows the handle to be lengthened or shortened according to the height of the tree. This apparatus is put up over the tree and the tent is allowed to rest upon it. By the use of this simple device the danger of breaking off the small twigs on the upper part of the tree by the weight of the tent is avoided. Mr. Leslis, of Orange, used four tents and tent-rests of this kind, and he informs me that with the aid of two men he fumigated 120 trees in one night. To remove the tent from one tree, place it over another, and charge the generator requires only one minute and a half. In the place of poles some persons attach a circle of gas pipe to the lower edge of the tent; then two men, each taking hold of opposite sides of this circle, throw the tent over the tree. Dr. J. H. Dunn, of Pomona, informs me that four men, using six tents like the above, fumigated 240 orange trees in one night, and that the average for each night was over 200 trees, the latter being 8 feet or less in height.

Trees over 12 feet tall will require a derrick of some kind for the purpose of putting on the tent and removing it again. For this purpose a stout mast is erected in the center of a strong framework mounted upon the running gears of a common farm wagon, the height of the mast depending upon the height of the trees to be operated upon. This mast is branched in four directions, and to the upper end of it is firmly attached a cross-piece, extending transversely to the length of the wagon, and long enough to reach from one row of trees to another. To each end of this cross-piece are attached small pulleys, through which pass ropes which are attached to the tents; by pulling down on these ropes the tents are drawn up to the cross-piece, after which the wagon is drawn ahead until the tents are directly over two of the trees to be treated; the ropes are then let out and the tents lowered down over the trees. The ropes are usually attached to the lower edge of the tents as well as to their apices, and when the tent is to be taken off of the tree the ropes attached to the bottom of it are first pulled downward, thus drawing the lower part of the tent up to the cross-piece first, and in a measure turning the tent inside out. But for this device it would be necessary to have the cross-piece at least twice the height of the trees to be operated upon. This apparatus is drawn between two rows of trees and the trees on each side of it treated with the gas. It is customary for the men themselves to draw the fumigator from tree to tree, thus doing away with the use of horses for this purpose. Stout planks are frequently used for the wheels of the fumigator to run upon. A fumigator of this kind, without the accompanying wagons and tents, can be built for about $15, it being the cheapest and simplest apparatus ever used for this purpose. It has not as yet been patented, and is more largely used at the present time than any other kind, operating the tents successfully even upon the largest orange trees. The first fumigator of this kind was built by Mr. O. H. Leefeld, a prominent orange-grower of Orange, and a man who has had considerable experience as a machinist.

Several other styles of tents are in use, but those described above sufficiently illustrate the requirements.

After the tent is placed over the tree the next step is to charge it with the gas. The materials used for the production of the gas consist of commercial sulphuric acid (K_2SO_4), fused potassium cyanide (KCN), and water, the proportions being 1 fluid ounce of the acid, 1 ounce by weight of the dry cyanide, and 2 fluid ounces of water. The generator is placed under the tent at the base of the tree, it consists of a common earthenware vessel. The water is first placed in the generator, then the acid,

and last the cyanide, after which the operator withdraws to the outside of the tent, and the bottom of the latter is fastened down by having a few shovelfuls of earth thrown upon it. The tent is allowed to remain over the tree for a period of from fifteen to thirty minutes according to the size of the tree.

It was found by experimenting that the trees were less liable to be injured by the gas when treated at night than they were when operated upon in the daytime, and at the same time the gas is just as fatal to the scale-insects when applied at night as it would be if applied in the daytime; and indeed it appears to be even more fatal when applied at night. This is accounted for by the reason of the fact that in the daytime the light and heat decompose the gas into other gases which, while being more hurtful to the trees, are not so fatal to insects. At night the trees are also more or less in a state of rest, and therefore are not so liable to be injured by the gas as they would be in the daytime, when they are actively engaged in absorbing nourishment and replacing wasted tissue with new materials.

Of the different materials used in generating the gas, the most important is the potassium cyanide; of this there are three grades, the mining cyanide, commercial cyanide, and the C. P. (chemically pure). Of these three brands, the mining cyanide is wholly unsuitable for the production of the gas, and the C. P. is too expensive; the commercial brand (fused) is the only one that is used for producing the gas, but even this varies greatly in strength, containing all the way from 33 to 58 per cent of pure potassium cyanide. It is therefore of the utmost importance that the operator should know the exact percentage of pure potassium cyanide that his cyanide contains, and when large quantities of it are purchased at one time it would be advisable to obtain one or more analyses of it by a reliable analytical chemist; or, if it is not possible to submit the cyanide to such persons, an analysis of it could be made by almost any person accustomed to the use of chemicals or drugs.

The potassium cyanide used for producing the hydrocyanic-acid gas is principally manufactured by two firms, Power & Weightman, of Philadelphia, Pa., and the Mallinkrodt Chemical Works, of St. Louis, Mo. That made by the first-named firm is the most largely used; when purchased by the ton the price is 26 cents per pound for the grade containing about 57 per cent of pure potassium cyanide, packages and carriage extra.

The quantity of cyanide to be used on each tree will, of course, depend not only upon the size of the tree, but also upon the strength of the cyanide used. The following table will aid in determining the proper quantity of each ingredient to be used in different-sized citrus trees, the cyanide being about 58 per cent pure:

Height of tree.	Diameter of tree top.	Water.	Sulphuric acid.	Potassium cyanide.
Feet.	*Feet.*	*Fluid oz.*	*Fluid oz.*	*Ounces.*
6	4	⅔	⅓	⅓
8	6	2	1	1
10	8	4½	2¼	2¼
12	10	8	4	4
12	14	16	8	8
14	10	10	5	5
14	14	19	9½	9½
16	12	16	8	8
16	16	29	14½	14½
18	14	26	13	13
20	16	36	18	18
22	18	52	26	26
24	20	66	33	33

The process of treating trees with hydrocyanic-acid gas for the destruction of scale-insects (family Coccidæ) is now being extensively used in southern California, not only in the orange groves, but also in the nursery, where the imported trees are subjected to this treatment for the purpose of ridding them of insect pests. In Orange County alone fully 200,000 orange and lemon trees have been subjected to this treatment the present year in order to free them from the red scale (*Aonidia aurantii* Maskell), for which scale the treatment was expressly devised.

This gas is also fatal to all armored scale-insects. The red spider and woolly aphis are not affected by it, however, when applied strong enough to destroy scale-insects. Most insects, however, succumb, but various kinds of useful ladybirds, although stupefied, finally recover and are apparently none the worse for the temporary loss of consciousness.

Although this process was worked out and completed by an agent of the Entomological Division of the Department of Agriculture, certain persons in California have succeeded, through misinterpretation and laxity of the patent system, in securing a patent on a mere legal technicality covering the valuable feature of applying the gas at night. There was not an iota of excuse for granting the patent in question (see Insect Life, Vol. III, pp. 457–460, and Vol. IV, pp. 46–47), and no hesitation is felt in advising the orange-growers of southern California to pay no heed to the claim of the patentees, and rather than attempt to buy this patent, as has been suggested, it will be wiser to combine and contest the fraudulent claims of the patentees in the courts.

REPORT OF THE ORNITHOLOGIST AND MAMMALOGIST.

SIR: I have the honor to submit herewith my sixth annual report of the doings of the Division of Ornithology and Mammalogy, covering the year 1891. It consists of two principal sections, in accordance with the two lines of work carried on by the division—the one, a study of the geographic distribution of species; the other, a study of the economic relations of mammals and birds beneficial or harmful from a directly economic standpoint.

As stated in previous reports, the office force of the division is wholly insufficient for the rapidly increasing demands of the investigations in hand. During the year 1891 more than two thousand letters were written and several hundred circulars and schedules were distributed. During the same period the number of letters received was about four thousand, and many of these were accompanied by schedules, lists, reports, or other records of observations, which were examined and either filed for future reference or at once utilized in studies already in progress. Other routine work consisted in attending to the needs of field agents, in identifying specimens, comparing and correcting proof, filing reports received, typewriting franks for the distribution of documents to American and foreign correspondents, compiling a reference list of publications useful in the regular work of the division, and miscellaneous work.

Respectfully,

C. HART MERRIAM,
Chief.

Hon. J. M. RUSK,
Secretary.

WORK OF THE YEAR.

SECTION OF GEOGRAPHIC DISTRIBUTION.

The work in the section of geographic distribution may be conveniently summarized under two heads, namely, (1) office work and (2) field work.

(1) *Office work.*—The office work has consisted, as heretofore, in the preparation and publication of reports based on the investigations of the division, and in the arrangement and identification of specimens received from field agents and others. The study series of mammals and birds belonging to the division has been so largely increased during the year that the entire time of one clerk is necessary for the proper care of the collection.

During the year the results of a biological reconnaissance made in Idaho during the summer of 1890 have been published in North American Fauna No. 5. This report contains an account of the six life zones of

central Idaho and the characteristic species of animals and plants found in each zone, together with notes on all the species of mammals, birds, and reptiles at present known to occur in the State.

(2) *Field work.*—During the year field work has been carried on in southeastern Texas by Clark P. Streator and William Lloyd, field agents of the division, who were engaged in working up the subtropical fauna along the lower Rio Grande River and on the Gulf coast. Late in the spring Mr. Streator was transferred to northern Idaho and Washington, where he continued work begun during the summer of 1890. He afterward crossed the Cascade Mountains and commenced work in the Puget Sound region.

The most important work of the year has been a biological survey of a large area in southern California and southern Nevada. This region was selected because of the exceptional advantages it offered for studying the distribution of animals and plants in relation to the effects of temperature and humidity at different altitudes from the bottom of Death Valley, which is below the level of the sea, to the summit of the High Sierra, culminating in the lofty snow-capped peaks about Mount Whitney, at an elevation of nearly 15,000 feet.

The close proximity of precipitous mountains and deep desert valleys often brings near together associations of species which in a more level country are characteristic of widely remote regions. In one place on the east side of the Sierra all the life zones of the North American continent from the plateau of Mexico to the Polar Sea may be crossed in traversing a distance of only 10 miles.

The Death Valley Expedition, for it soon came to be universally known by this name, was organized for the purpose of determining the actual boundaries of the several life zones of the region and studying the problems involved in the laws governing this distribution. The expedition outfitted at San Bernardino, in southern California, the last week in December, 1890, and set out through Cajon Pass, January 3, 1891, bound for the Mohave Desert and the region to the northward. In its personnel it comprised some of the ablest and most experienced field naturalists in the world. Vernon Bailey, E. W. Nelson, Theodore S. Palmer, Dr. A. K. Fisher, F. Stephens, and Basil Hicks Dutcher, belonged to the division force, and each was in charge of a branch party at some time during the season.

By coöperation with the Division of Botany a competent botanist, Mr. F. V. Coville, and a botanical assistant, Mr. F. Funston, were detailed to accompany the expedition, and remained in the field throughout the season, making enormous collections of grasses and other plants, including many new species.

By coöperation with the Division of Entomology an experienced insect collector, Mr. Albert Koebele, joined the main party in the Mohave Desert early in April and remained nearly six weeks, making important collections in Death and Panamint valleys and in the Panamint and Argus mountains.

By coöperation with the Meteorological Division of the Signal Service of the War Department, since transferred (July 1, 1891) to the Department of Agriculture as the Weather Bureau, a meteorological station was established below sea level in Death Valley in April, where continuous observations were taken until the latter part of September. About the middle of June another station was established near timber line in the High Sierra (at a little above 10,000 feet altitude). The permanent station at Keeler, on Owens Lake (altitude 3,600 feet), in the heart of the region under investigation, served as a base station. Moreover, by

coöperation with the local State weather services of Nevada and California, the Weather Bureau has furnished records from several other stations in and adjacent to the area covered by the biological survey. Thus simultaneous meteorologic observations are at hand from a number of distinct and widely different localities, resulting in series of thermometric, barometric, and hygrometric data never before available in work of this character.

From the time the expedition took the field, the first week in January, until my arrival, the last week in March, Mr. Theodore S. Palmer was in charge; and he was again placed at the head about the middle of July, when I was unexpectedly called away on a special mission to Bering Sea, and remained in charge until the main party disbanded at Visalia, September 19, 1891.

The area of which a biological survey was made comprises about 100,000 square miles in southern California and Nevada, situated between the parallels of 34° 30′ and 38° north latitude. It comprises also a small area in northwestern Arizona and southwestern Utah, thus including all of the torrid desert valleys and basin ranges between the High Sierra and the Colorado Plateau. The great Sierra Nevada was crossed along four distinct lines, and both slopes were worked with considerable detail. The Mohave Desert was traversed in various directions, and was worked to its extreme western end. Some work was done also in the Tejon Mountains—the westward continuation of the Sierra—in the Cañada de las Uvas, the San Joaquin Valley, and the coast region in Monterey and San Luis Obispo counties.

Thus a broad zone, more than 200 miles in breadth and 500 in greatest length, stretching from the Pacific Ocean to the Colorado Plateau in Utah and Arizona, was covered by the operations of the division; and the survey of the present summer was practically connected with the biological survey of the San Francisco Mountain region in Arizona, made during the summer of 1889. (See North American Fauna, No. 3.)

The collections brought back to Washington by the Death Valley Expedition and deposited in the U. S. National Museum comprise about 1,000 reptiles and batrachians, 1,000 birds, 5,500 mammals, 4,500 insects, and 18,000 plants, besides a number of fishes and mollusks from the hot springs of some of the interior deserts, and several hundred miscellaneous specimens.

One of the special objects of the expedition was the determination of the northern boundary of the Lower Sonoran life zone in the Great Basin—a matter of considerable importance, because this zone marks the northern limit of successful raisin production and of the profitable cultivation of several subtropical fruits and other crops. The attempt to fix this boundary was undertaken with some misgiving by Mr. Bailey and myself, and was accomplished with great satisfaction after a horseback journey of about 1,700 miles. We succeeded in tracing the line in question completely across the deserts and barren ranges of the Great Basin all the way from the foot of the High Sierra in California to the foot of the Great Colorado Plateau in Utah; and later in the season other members of the expedition carried it northward along the west base of the Sierra.

The inexhaustible fertility of the soil in most parts of the arid region, and consequent high value of agricultural lands wherever water may be had in quantity sufficient for irrigation, taken in connection with the recent unparalleled development of the fruit-growing industry in southern California and Arizona, make it of the utmost importance to

know beforehand just what crops are likely to prove most successful in each particular place, and point to the advantages that would result from mapping the boundaries of the areas fitted by nature for each of these products; for different parts of the Lower Sonoran zone are adapted not only to the successful cultivation of cotton and tobacco, but also to the needs of the orange, fig, and raisin grape.

Without going into details it may be said, in advance of the forthcoming report on the results of the biological survey of 1891, that the following valleys and deserts have been ascertained to belong to this zone: In California, the San Joaquin Valley, the whole of the Mohave and Colorado deserts, the San Bernardino, San Gabriel, and Santa Ana valleys, and the coast region to the southward except the mountains, the southern end of Owens Valley, Saline, Salt Wells, Panamint, and Death valleys; in Nevada, the Amargosa Desert, Pahrump, Indian Springs, Vegas, Ivanpah, and Virgin valleys; and in Utah, the St. George or lower Santa Clara Valley. The latter was colonized by Mormons many years ago, and the presence of the pride-of-India or China tree, ailanthus, osage-orange, mulberry, flowering cypress or tamarisk, fig, and tobacco trees, along the streets of their thrifty villages was a pleasing confirmation of the bio-geographical position of the valley as ascertained by a study of its indigenous fauna and flora before the settlements were reached.

SECTION OF ECONOMIC RELATIONS.

The work of this section has been confined during the year almost entirely to ornithology, and a large amount of work has been done toward the completion of the bulletins mentioned last year.

The illustrated bulletin on hawks and owls still remains unpublished, through lack of funds to pay for reproducing the colored plates. Meanwhile the text has been thoroughly revised and considerable new matter has been added.

Special effort was made during the past spring and summer to procure the stomachs of old and young crows in corn-planting time and during the breeding season of the smaller birds. About 250 such stomachs were obtained from the District of Columbia and adjacent parts of Maryland and Virginia, while smaller numbers were secured from half a dozen other States. This material is now being examined, and probably will supply most of the data necessary to complete the bulletin on the crow.

Material for the bulletin on crow-blackbirds has been less difficult to obtain than that relating to crows, and already about 800 stomachs are at hand, and more than half have undergone preliminary examination. Other matter for this bulletin has accumulated also, and its publication will follow directly that on the crow.

The collection of stomachs has been very largely increased during the past year, the accessions being nearly twice as great as for the year 1890. This increase is due in part to the special efforts made to secure stomachs of crows and blackbirds, and in part to the increased interest in the work of the division. The collection now contains 13,712 stomachs.

The reference collection of seeds has been augmented by several important contributions, and now numbers 380 genera and 600 species, but still lacks many of the species on which our wild birds feed. Many of our common birds range over thousands of miles in their trips to and fro between their winter quarters and their breeding grounds. Their food during one part of the year may consist largely of fruits and seeds

peculiar to a cold climate, and at another season of the productions of the tropics. It is evident, therefore, that studies of the food habits of such birds present unusual difficulty. A species may be watched in the field by competent naturalists and followed from place to place during its migrations. In addition, stomachs collected at various seasons may be carefully examined by experts in the laboratory. A judicious combination of these methods gives the strongest promise of success, but the laboratory examinations lose most of their value unless a good reference collection of the food materials from the entire range of the bird be kept at hand.

In order properly to identify the fragments of vegetable and animal matter in bird stomachs it was found necessary to prepare for permanent use a series of slides for the microscope, showing sections or bits of the more important materials likely to occur as bird food. Such a collection was begun during the summer, and will be increased as rapidly as circumstances permit.

Considerable attention has been given to the English sparrow question during the year, and it is evident that this bird will continue to be a pest in most sections of the country unless its increase is checked by intelligent action in the different States. Several States have legislated against it ineffectually, their failure being due largely to ignorance of the true habits of the bird and a lack of appreciation of the magnitude and gravity of the evil.

Michigan and Ohio have wasted many thousands of dollars in bounties nominally for heads of English sparrows, but actually in large part for the heads of harmless or beneficial birds. Illinois recently enacted a sparrow law giving bounties for heads during the winter months, but this also can result at best in only a slight diminution of the number of sparrows and at a disproportionate expense.

The sparrow sooner or later will force itself on the attention of every agricultural State in the Union, and it would be the part of wisdom for sections not yet badly afflicted by the scourge to take immediate steps to secure continued immunity. General directions for such action have been given already in the bulletin published in 1889, and it only remains for each State or county to work out the details of the plan which may best suit its peculiar needs. Bounty laws are worse than useless; the best prospect of relief appears to be through the organization in each State of a sparrow board or commission, which shall employ trained assistants to destroy nests and young during warm weather and make use of poison in cold weather, and in such ways as not to endanger the lives of our valuable native birds.

REPORT OF THE STATISTICIAN.

SIR: I have the honor to submit my twenty-third annual report as Statistician of the Department of Agriculture.

The number and character of statistical exchanges received during the year attest the growth of statistical inquiry in the civilized countries of the world. The organization for such service has been in no inconsiderable part the growth of the past thirty years. It is only within a very brief period that some of the most advanced nations have made any official effort at crop enumeration or even crop estimation. Some of the nations of the largest production, even now, do not officially report crop areas. There is still room for improvement in the practice, if not the methods, of investigation in the most successful and advanced national systems of statistical collection.

The existence of these facts is not an evidence of nonprogressiveness. On the contrary, the rate of progress is accelerating and the status materially advanced. The impulsive and thoughtless appropriator of statistiscal results, who fails to realize the labor and difficulty of obtaining them, has no reason or excuse for criticising incompleteness resulting from necessary and natural limitations of accomplishment. The principal limitation of statistical effort is found in the ignorance and prejudice and lack of appreciation which statistical inquiry encounters. In only the most intelligent and progressive nations is general statistical research into the labors and condition of the masses at all practicable. This explains the nonexistence of such statistics for a very large portion of the world's surface, and their incompleteness in most of the remaining area.

The development of this line of research has been remarkable in recent years. Educational, financial, commercial, industrial, and agricultural organizations for statistical inquiry have sprung into existence with great rapidity. States, nations, empires, have multiplied official systems, and the International Statistical Institute, for several years in successful operation, unites administrative and scientific statisticians in a persistent effort for unifying and increasing the work of collecting and consolidating comparative international statistics. The field is broad, obstructions to progress are numerous, and, however zeal and labor may unite for its cultivation, the fact remains that a long period of ever-broadening effort will be required to reach the ideal of possible attainment.

The superficial thinker sees existing statistical activity, observes the universal search for a statistical basis of action in many lines, and demands data, reasonable and unreasonable, practicable and impossible, with equal eagerness and assurance, apparently with no thought that the attainable in existing statistics is less illimitable than space or less exact than mathematics. This suggests some of the difficulties under

which an efficient statistician in any country labors in his endeavors to meet current requirements for statistical information.

The demand for statistical data by legislators, foreign ambassadors, administrative officials, industrial and commercial organizations, taxes severely the facilities of this office, as of every other official repository of statistics and source of original investigation. The demand is legitimate, and is cheerfully met to the limit of the practicable. There are other demands, however. In consonance with the spirit animating endeavor in the Department of Agriculture, the desire to be in touch with the rural masses and helpful to all their needs, individual requests for information are welcomed and given cheerful response. Only regret is felt for inability to deal fully with correspondence so voluminous and sometimes so overwhelming. There is one demand, quite extensive and very urgent, that appears to be not so well grounded in public policy and equal justice. It is that of the bookmaker or professional writer, whose pen is adjutant to his purse, whose aims, however philanthropic, are subordinated to the personal and pecuniary. It seems a question, sometimes a delicate one, to decide how far his assumption of public benefaction may go as a warrant for the use of public money to advance private enterprise. Giving the public treasury the benefit of the doubt, it has sometimes been necessary to decline investigations and refuse laborious compilations desired mainly for their money value to the applicant.

Several investigations intended to furnish material for local bulletins, agricultural surveys of certain States and districts, are well advanced, and the results will soon be published. The monthly reports of the Statistician have been enriched with an unusual proportion of domestic and foreign original matter, editorial and compilation. A series of descriptions of the geographical character and agricultural resources of South American countries, with statistics of production and distribution, of products exported and commodities imported, has been included during the past year, and will be issued in a separate bulletin. The manifest need of economic and financial information, in view of the marked tendency to coöperative effort and self-help on the commercial side of agriculture, gives a positive interest to the subject of people's banks existing in Europe. Brief explanations of their constitutions, methods, and results have been printed in recent issues of this report, which will be gathered in a separate bulletin. Practical instruction in associated business operations, and experience in such practice, will render coöperation practicable and safe, and do much to eliminate the unnecessary expense of the superfluous middleman and enlarge the profits of agriculture.

Editions have been printed, during the year, of the Album of Agricultural Statistics and of the Album of Agricultural Graphics, which have been highly commended by professors and teachers in all grades of educational institutions. They are especially valuable in those people's colleges, the Farmers' Institutes, where they supply a want hitherto greatly felt, furnishing information otherwise unattainable and helping to answer difficult questions which occasionally arise in the institutes.

Our crop-reporting system, while not a census, is far better than a poor one, and has the merit of unexampled promptness, as only a fortnight elapses from the forwarding of returns from all parts of this country and from Europe to the publication of revised results. These results are approximately correct, controlling the erratic movement of prices that might otherwise result from wild and reckless estimates put

forth to influence the market for the benefit of speculators and to the injury of producers. They have so well withstood the tests of time, as made by the records of distribution, that they are quoted and relied on more than any other statistics of current agricultural production. In foreign countries the system has attracted attention and elicited inquiry, and has to some extent been adopted in collection of crop statistics. Foreign Governments, through their administrative statisticians, have solicited detailed descriptions of the methods and appliances employed, with a view of bettering their own systems and work.

The marvel of these results is their cheapness in actual cost. Labor worth a half million dollars is freely given by the thousands of our reporters in every section of the country for the advancement of agriculture. It is mainly incidental labor, not interfering especially with other occupations, yet it is systematic, the result of careful observation and matured judgment. But there are limitations to the possibilities of this service. It is unreasonable to expect and unjust to ask, in this practical age, for more continuous and consecutive service, and yet completeness and value of results often require such supplementary or special work. There is a fund "for the collection of statistics," which, however, is burdened by law with the salary roll of the State agents and the compilation of freight rates and other expenditures, and the remnant is too small for much field work in original statistics. Considering the millions spent annually in several branches of statistical and scientific inquiry, the urgent demand for prompt indications of the range of production and prices, surplus and deficiency, in this country and in Europe, is too pressing to be disregarded. Larger appropriations for this purpose are imperatively required. The interests of the agricultural masses require it; the successful foiling of schemes of speculative plunder demands it; the duty of the Government for the protection of producers and consumers impels it. To refuse it is to throw away millions to save thousands, to save by drops and waste by torrents.

J. R. DODGE,
Statistician.

Hon. J. M. RUSK,
Secretary.

CROPS OF THE YEAR.

METEOROLOGY.

An examination of the meteorological records covering the growing season of 1891 shows that in the main the weather of that portion of the year was characterized by a marked deficiency in temperature and an equally prominent deficiency in rainfall. These general characteristics were especially prominent in the meteorological districts which comprise the principal agricultural sections of the country. April opened the crop year with a record which showed usually but little variance from the normal of that month for a series of years, the principal departure being in the matter of temperature in the Lake regions, the Mississippi and Missouri valleys, and the extreme Northwest, where the range was from 2° to nearly 6° above the average. Rainfall, where there was any appreciable variation, was rather under than over the usual record.

A knowledge of the temperature and rainfall prevailing during the growing season is absolutely essential to a full understanding of crop results; and in order that a study of the record in detail may be made, the following statement, showing temperature and rainfall by months

during the planting, growing, and harvesting season in all sections of the country, is presented. The figures are from the official records of the Weather Bureau and give the normal record of the month, as computed from the observations of a series of years, in comparison with the results of observations for the present year.

Temperature.

Districts.	April.		May.		June.		July.		August.		September.	
	For several years.	1891.	For several years.	1891.	For several years.	1891.	For several years.	1891.	For several years.	1891.	For several years.	1891.
	°	°	°	°	°	°	°	°	°	°	°	°
New England	43.6	45.6	53.7	52.9	62.8	62.5	68.8	65.6	66.8	68.3	60.7	64.8
Middle Atlantic States	51.6	54.2	62.4	60.7	70.9	71.1	76.2	71.9	73.5	74.4	67.9	70.8
South Atlantic States	61.4	62.5	70.3	67.6	76.6	77.6	80.5	77.3	78.7	79.5	74.2	74.7
Florida peninsula	......	......	......	......	......	......	......	......	......	......	......	......
Eastern Gulf States	66.5	65.8	73.0	71.3	78.9	80.4	81.6	79.2	79.8	79.6	75.9	76.1
Western Gulf States	66.9	66.0	73.3	70.6	79.5	80.0	82.9	80.4	81.1	79.3	75.5	76.0
Rio Grande Valley	75.2	72.4	79.5	77.4	83.3	85.3	85.3	85.7	84.9	83.7	80.8	80.2
Ohio Valley and Tennessee	56.1	58.2	65.5	62.7	73.3	75.9	77.7	73.1	74.6	73.8	68.7	71.3
Lower Lake region	44.2	47.2	56.3	53.9	65.9	67.1	71.9	67.0	68.4	69.2	62.4	67.0
Upper Lake region	40.1	42.5	51.4	50.4	61.2	61.9	68.2	63.4	65.1	65.5	58.5	64.3
Extreme Northwest	41.5	47.3	54.1	54.2	65.2	61.0	68.4	63.4	65.2	64.4	54.9	60.2
Upper Mississippi Valley	51.3	53.3	61.5	59.9	70.4	71.2	75.8	70.0	72.1	70.8	64.4	69.8
Missouri Valley	51.1	53.1	60.6	58.6	69.9	67.8	75.5	70.2	71.1	70.5	62.8	68.0
Northern slope	45.7	47.7	54.2	54.8	64.2	60.3	70.5	66.9	68.1	67.3	57.6	60.0
Middle slope	51.5	52.7	60.6	59.4	70.6	67.4	75.8	72.0	72.8	72.5	65.2	67.7
Southern slope	63.0	61.8	70.8	67.4	77.8	77.3	82.5	80.5	......	......	......	......
Southern plateau	59.2	59.1	67.6	66.1	76.3	74.1	79.6	80.2	79.6	80.3	72.4	74.1
Middle plateau	48.9	47.5	57.2	57.2	65.7	61.5	72.4	71.5	71.4	71.3	61.8	62.5
Northern plateau	......	......	......	......	......	......	......	......	......	......	......	......
North Pacific coast region	50.1	49.8	55.0	55.2	58.9	57.3	61.1	62.0	60.8	63.8	58.2	57.9
Middle Pacific coast region	58.6	56.3	63.6	61.6	67.7	67.1	71.3	72.8	71.7	73.7	68.3	68.2
South Pacific coast region	59.6	58.8	61.9	61.2	66.5	65.0	69.9	71.4	71.2	73.6	68.8	71.6

Precipitation.

Districts.	April.		May.		June.		July.		August.		September.	
	Normal.	1891.	Normal.	1891.	Normal.	1891.	Normal.	1891.	Normal.	1891.	Normal.	1891.
	In.	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
New England	3.50	2.29	3.57	1.99	3.09	2.48	4.43	3.53	4.57	3.67	3.87	2.67
Middle Atlantic States	3.44	2.33	3.60	3.26	3.83	2.68	4.58	6.78	4.85	4.85	4.02	2.52
South Atlantic States	3.88	1.71	3.84	3.65	5.16	3.02	6.28	6.88	6.58	8.08	5.71	4.31
Florida peninsula	1.58	1.79	......	......	......	......	7.30	2.70	......	......	......	......
Eastern Gulf States	5.00	1.70	4.42	1.72	5.61	4.97	5.42	5.32	5.67	2.07	4.51	2.11
Western Gulf States	4.05	3.90	4.55	1.51	3.84	2.64	3.07	4.47	3.62	2.52	4.24	3.04
Rio Grande Valley	1.37	2.88	1.28	2.22	2.69	0.99	1.71	1.61	3.54	1.24	5.85	5.25
Ohio Valley and Tennessee	4.04	2.14	3.96	1.92	4.34	4.47	3.95	4.75	3.77	3.47	3.14	1.54
Lower Lake region	2.37	1.81	3.27	1.45	3.75	2.52	3.26	3.06	3.03	2.43	3.07	1.57
Upper Lake region	2.30	2.22	3.30	1.23	3.91	2.45	3.20	2.80	3.11	4.11	3.62	1.52
Extreme Northwest	1.57	2.18	2.12	1.61	3.42	5.67	2.93	3.33	2.17	1.97	1.76	1.86
Upper Mississippi Valley	2.85	2.51	4.16	2.26	4.93	4.10	3.75	2.95	3.23	4.03	3.58	1.08
Missouri Valley	3.92	3.41	4.14	3.22	4.51	6.05	3.88	2.98	2.85	1.65	2.53	0.73
Northern slope	1.42	1.60	2.35	2.91	2.41	3.76	2.18	2.88	1.89	2.09	1.14	1.14
Middle slope	2.25	2.18	3.32	3.50	3.00	4.29	2.58	2.98	2.93	1.63	1.51	2.81
Southern slope	2.65	2.32	3.21	2.79	3.00	3.12	2.49	2.89	3.88	1.48	2.57	1.17
Southern plateau	0.33	0.03	0.31	1.08	0.53	0.28	2.13	0.53	1.30	0.30	0.68	1.28
Middle plateau	1.61	1.00	1.05	1.43	0.60	0.76	0.50	0.80	0.83	0.53	0.64	1.24
Northern plateau	1.37	0.77	1.58	0.74	1.64	3.44	0.62	1.22	......	......	......	......
North Pacific coast region	3.74	5.97	2.93	2.00	2.52	4.03	1.07	0.67	1.32	1.52	3.03	4.63
Middle Pacific coast region	2.43	2.25	0.92	1.14	0.34	0.24	0.00	0.09	0.01	0.01	0.35	0.35
South Pacific coast region	1.31	0.84	0.37	0.23	0.09	0.02	0.00	T.	0.10	0.00	0.07	0.07

From the data above presented a showing of the aggregate rainfall during the six months under consideration in the principal agricultural districts is made up. This compilation shows that the season was

remarkably dry in all sections except the extreme Northwest and the north Pacific coast region. The seasonal deficiency was most marked in the eastern Gulf States, where the precipitation was 12.74 inches less than the average, but little more than half of the normal quantity being received. There was also a considerable deficiency in other sections of the cotton belt, amounting to 3.80 inches in the south Atlantic States and 5.29 inches in the western Gulf region. In the corn belt the deficiency was quite marked, ranging from 3.79 inches in the Missouri Valley to 5.91 inches in the lower Lake region.

The aggregate rainfall for the period under consideration in the principal districts, with the departure from the normal, for two seasons is presented:

Aggregate rainfall.

Districts.	1891.			1890.		
	Normal.	For the year.	Departure from the normal.	Normal.	For the year.	Departure from the normal.
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
New England	23.03	16.63	− 6.40	21.49	22.44	+0.95
Middle Atlantic States	24.32	22.42	− 1.90	23.39	25.75	+2.36
South Atlantic States	31.45	27.65	− 3.80	31.53	32.22	+0.69
Eastern Gulf States	30.63	17.89	−12.74	30.37	29.21	−1.16
Western Gulf States	23.37	18.08	− 5.29	23.83	26.85	+3.02
Ohio Valley and Tennessee	23.20	18.29	− 4.91	23.22	25.37	+2.15
Lower Lake region	18.75	12.84	− 5.91	19.82	22.55	+2.73
Upper Lake region	19.44	14.33	− 5.11	20.24	17.37	−2.87
Extreme Northwest	13.97	16.62	+ 2.65	14.35	13.96	−0.39
Upper Mississippi Valley	22.50	16.93	− 5.57	23.05	18.88	−4.17
Missouri Valley	21.83	18.04	− 3.79	21.18	15.33	−5.85
North Pacific coast region	14.61	18.82	+ 4.21	14.77	10.07	−4.70

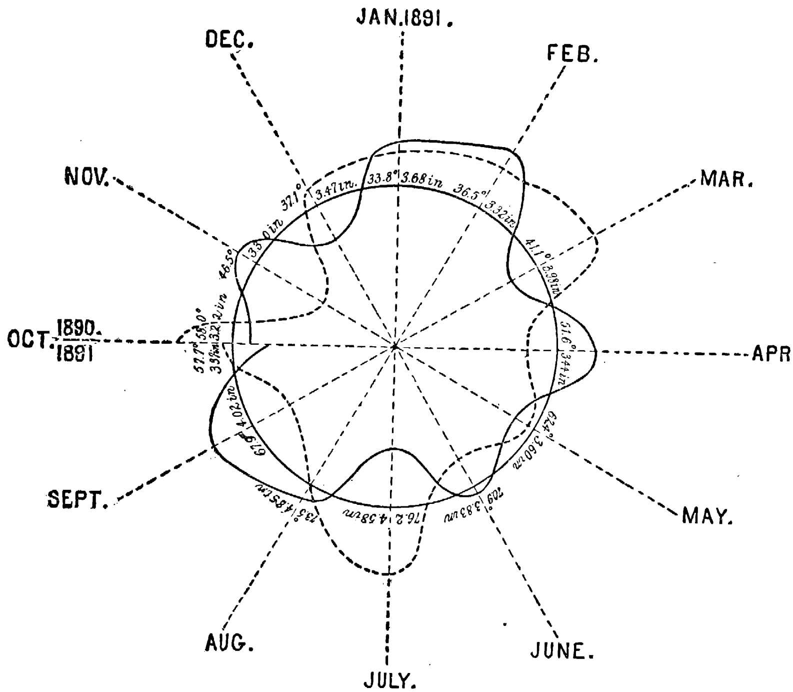
The monthly departures from the normal, both in temperature and rainfall, for each district are presented to facilitate a study of the detailed meteorology of the year in relation to agricultural production:

Departures of temperature and rainfall from the normal.

Districts.	April.		May.		June.		July.		August.		September.	
	Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.
	°	*Inch.*	°	*Inch.*	°	*Inch.*	°	*Inch.*	°	*Inch.*	°	*Inch.*
New England	+2.0	−1.21	−0.8	−1.58	−0.3	−0.61	−3.2	−0.9	+1.5	−0.9	+4.1	−1.2
Middle Atlantic States	+2.6	−1.11	−1.7	−0.34	+0.2	−1.15	−4.3	+2.2	+0.9	0.0	+2.9	−1.5
South Atlantic States	+1.1	−2.17	−2.7	−0.19	+1.0	−2.14	−3.2	+0.6	+0.8	+1.5	+0.5	−1.4
Florida peninsula	......	+0.21	......	......	......	......	......	−4.6	......	......	......	......
Eastern Gulf States	−0.7	−3.30	−1.7	−2.70	+1.5	−0.64	−2.4	−0.1	−0.2	−3.6	+0.2	−2.4
Western Gulf States	−0.9	−0.15	−2.7	−3.04	+0.5	−1.20	−2.5	+1.4	−1.8	−1.1	+0.5	−1.2
Rio Grande Valley	−2.8	+1.51	−2.1	+0.94	+2.0	−1.70	+0.4	−0.1	−1.2	−2.3	−0.6	−0.6
Ohio Valley and Tennessee	+2.1	−1.90	−2.8	−2.04	+2.6	+0.13	−4.6	+0.8	−0.8	−0.3	+2.6	−1.6
Lower Lake region	+3.0	−0.56	−2.4	−1.82	+1.2	−1.23	−4.9	−0.2	+0.8	−0.6	+4.6	−1.5
Upper Lake region	+2.4	−0.08	−1.0	−2.07	+0.7	−1.46	−4.8	−0.4	+0.4	+1.0	+5.8	−2.1
Extreme Northwest	+5.8	+0.61	+0.1	−0.51	−4.2	+2.25	−5.0	+0.4	−0.8	−0.2	+5.3	+0.1
Upper Mississippi Valley	+2.0	−0.34	−1.6	−1.90	+0.8	−0.83	−5.8	−0.8	−1.3	+0.8	+5.4	−2.5
Missouri Valley	+2.0	−0.51	−2.0	−0.92	−2.1	+1.54	−5.3	−0.9	−0.6	−1.2	+5.2	−1.8
Northern slope	+2.0	+0.18	+0.6	+0.56	−3.9	+1.35	−3.6	+0.7	−0.8	+0.2	+2.4	0.0
Middle slope	+1.2	−0.07	−1.2	+0.18	−3.2	+1.29	−3.8	+0.4	−0.3	−1.3	+2.5	+1.3
Southern slope	−1.2	−0.33	−3.4	−0.42	−0.5	+0.12	−2.0	+0.4	......	−2.4	......	−1.4
Southern plateau	−0.1	−0.30	−1.5	+0.77	−2.2	−0.25	+0.6	−1.6	+0.7	−1.0	+1.7	+0.6
Middle plateau	−1.4	−0.61	0.0	+0.38	−4.2	+0.16	−0.9	+0.3	−0.1	−0.3	+0.7	+0.6
Northern plateau	......	−0.60	......	−0.84	......	+1.80	......	+0.6	......	......	......	......
North Pacific coast region	−0.3	+2.23	+0.2	−0.93	−1.6	+1.51	+0.9	−0.4	+3.0	+0.2	−0.3	+1.6
Middle Pacific coast region	−2.3	−0.18	−2.0	+0.22	−0.6	−0.10	+1.5	+0.1	+2.0	0.0	−0.1	0.0
South Pacific coast region	−0.8	−0.47	−0.7	−0.14	−1.5	−0.07	+1.5	0.0	+2.4	0.1	+2.8	0.0

For the purpose of making a graphic showing of the weather conditions which have prevailed during the past crop year, a series of diagrams have been prepared giving the monthly record in four of the principal agricultural districts of the country. The period covered is from October, 1890, to October, 1891, inclusive, thus including the whole crop year from the seeding of winter wheat to the harvest of all crops.

The mechanical arrangement of the diagram is simple and very clear, the course of the seasons being so strikingly presented that a better understanding can be had from its study than can be obtained from any examination of the tabulated record. In the plan followed each line radiating from the center represents one month of the period. The point where the circle crosses these radiating lines represents the normal of the month in either temperature or rainfall, and this normal is

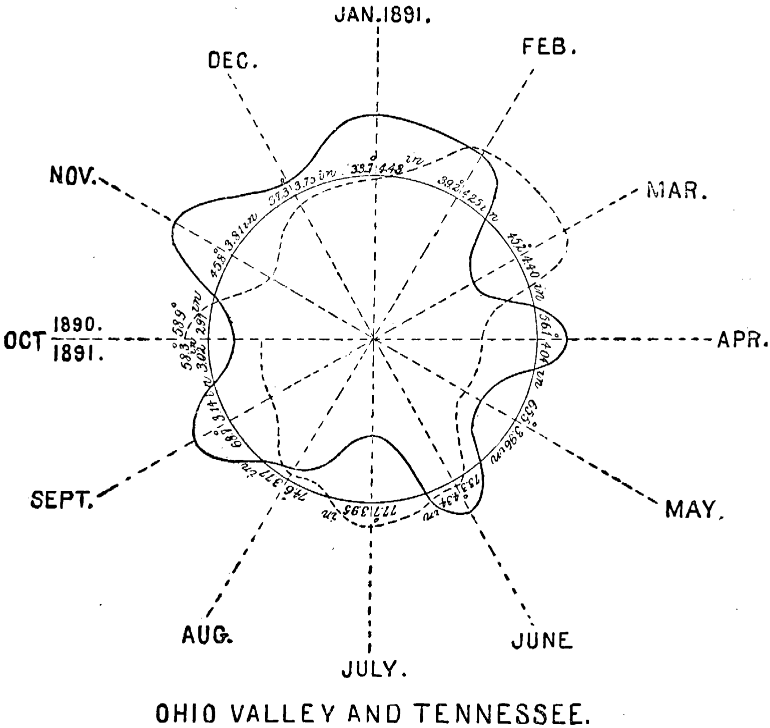


MIDDLE ATLANTIC STATES.

further shown in figures of degrees or inches. The heavy black line in its course from month to month represents the actual range of the temperature for the period, running outside of the normal circle where it is above the average for a series of years and inside where it is below. The light dotted line represents rainfall in the same manner. The distance from the normal circle at which these lines cross the month line shows the departure from the normal for that month, and to further facilitate a study of the record the actual departure for each month is given in a table presented at the close of this chapter.

A study of these data reveals some peculiar facts, which could hardly be appreciated except when presented by this graphic method. The

general trend of temperature was very much the same in the four dis, tricts selected during the fall and winter months. In each case October-1890, was in about the same proportion below the normal, while from November to February the weather was considerably warmer than usual, except December in the middle Atlantic States. The sudden bend in the line representing temperature in each diagram, for March, shows the remarkable change from a warm winter to an unusually cold opening of spring. This depression of temperature continued in the western Gulf States until June, but elsewhere there was an equally sudden reaction, carrying the April average considerably above the normal. Except in the Atlantic States, June was the only month between April and September in which temperature ranges outside the normal circle. During the same period the dotted line representing rainfall passes above the normal only in July, these two conditions characterizing the summer as cool and dry.



OHIO VALLEY AND TENNESSEE.

Perhaps one of the most peculiar facts to be noted is the remarkable evening up of temperature which appears to occur in periods of six months. In the period under consideration a departure from the normal in one month is almost uniformly balanced by a similar departure in the opposite direction six months later.

Selecting the diagram representing the record of the middle Atlantic States as an example, it may be seen that the inward curve of the line of temperature for October, 1890, is balanced six months later by a similar outward curve in April. An excess of temperature in November is similarly balanced by an almost equal deficiency in May, while a

deficiency in December is offset on the opposite side of the circle by an excess in June. January shows a decided outward curve, while in July the line bends as much in the opposite direction. The relation between February and August proves an exception to the rule, but in the succeeding month it is again asserted, the line bending sharply in for March and as sharply out for September.

Of course the record of a single year, when considered by itself, can not be assumed as even partially establishing a rule, but in this case at least it affords some ground for the belief, popular among the weather-wise who predict by "the signs," that a warm winter is followed by a cool summer, nature working to maintain an equilibrium during the year.

For convenience in studying the diagrams the departures both in temperature and rainfall from the normal for each month are thus shown:

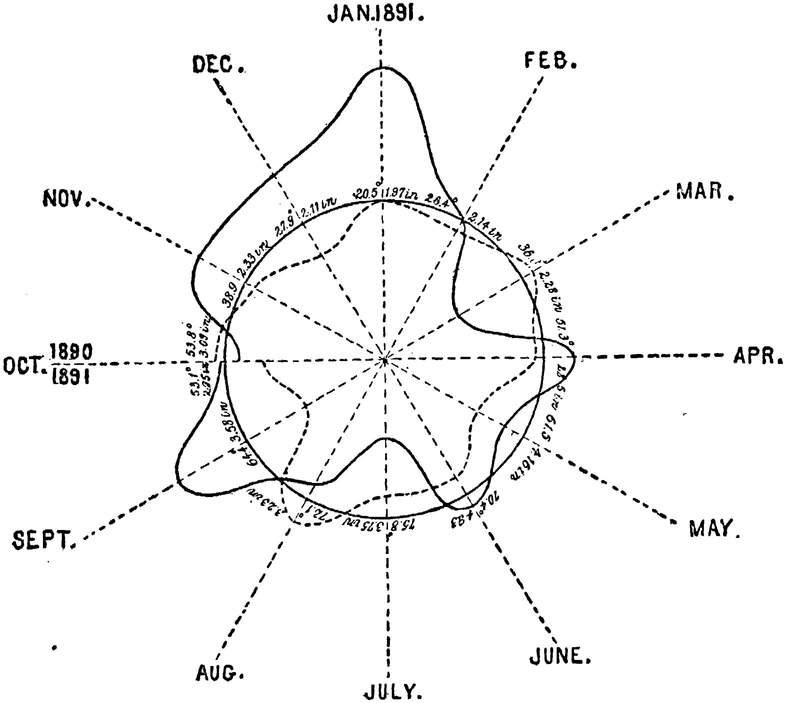
Months.	Middle Atlantic States.		Western Gulf States.		Ohio Valley and Tennessee.		Upper Mississippi Valley.	
	Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.
1890.	°	*Inches.*	°	*Inches.*	°	*Inches.*	°	*Inches.*
October	−1.3	+1.77	−1.4	+0.57	−1.7	+0.82	−1.2	+0.26
November	+1.2	−2.73	+2.8	−0.87	+4.6	−1.49	+3.7	−0.51
December	−2.9	+0.53	+2.9	−1.91	+1.1	−0.42	+3.9	−1.38
1891.								
January	+2.9	+1.08	+1.7	+2.38	+4.4	−0.08	+9.3	−0.01
February	+4.4	+1.51	+1.2	−1.45	+3.4	+1.89	+0.2	−0.41
March	−2.2	+2.10	−5.2	−0.34	−3.6	+2.03	−5.4	+0.36
April	+2.6	−1.11	−0.9	−0.15	+2.1	−1.90	+2.0	−0.34
May	−1.7	−0.34	−2.7	−3.04	−2.8	−2.04	−1.6	−1.90
June	+0.2	−1.15	+0.5	−1.20	+2.6	+0.13	+0.8	−0.83
July	−4.3	+2.20	−2.5	+1.40	−4.6	+0.80	−5.8	−0.80
August	+0.9	0.00	−1.8	−1.10	−0.8	−0.30	−1.3	+0.80
September	+2.9	−1.50	+0.5	−1.20	+2.6	−1.60	+5.4	−2.50
October	−2.7	+0.20	−1.7	−2.80	−1.8	−1.80	+0.1	−1.40

EFFECT OF THESE CONDITIONS ON THE CROPS.

The relative high temperature of April, with slightly deficient rainfall, gave excellent opportunity for careful preparation of the seed bed for spring crops and for the prosecution of seeding. During May the characteristics which marked the season began to be felt. With but two exceptions, trifling in their nature, there was a marked deficiency in temperature in every district in the country, while the rainfall was almost as generally below the usual supply for the month. Conditions very similar prevailed during the succeeding months of June, July, and August, with the exception that June was marked by a generally sufficient supply of rainfall. The absence of moisture was seriously felt in the upper valley of the Mississippi, especially in Wisconsin and parts of Minnesota.

In this district there was a continued deficiency from March to September, not especially heavy in any part of the period, but continued long enough to affect materially crop conditions during the growing season and stunting the final yield per acre. The cool weather which the summer developed did not affect the small grain crops, except to make harvest a little late, but as this was prosecuted under favorable conditions of temperature and rainfall no damage was done. It did affect seriously, however, the prospect of the corn crop, checking growth and development, and as the weeks passed by the apprehensions excited found expression in a general fear for the crop. Cool weather and

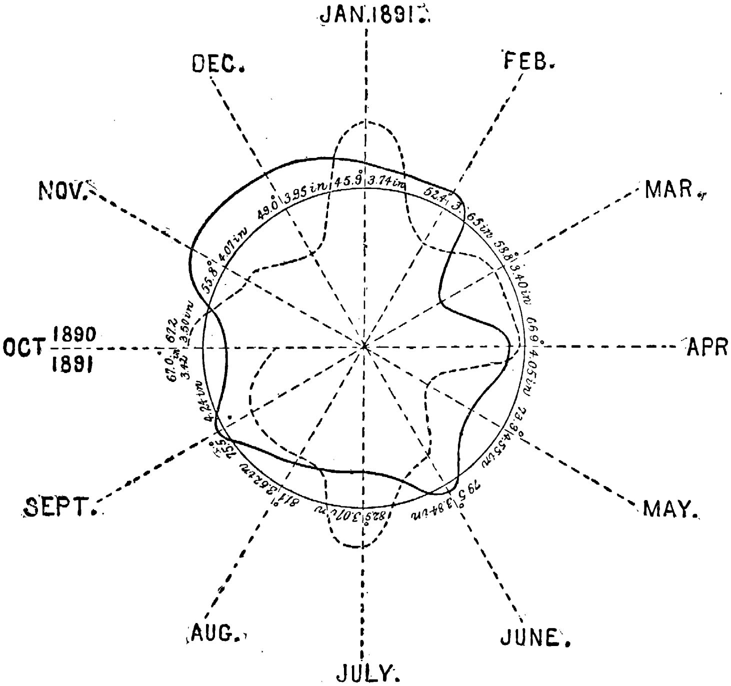
a lack of moisture made it very late at the close of August, and in view of the previous record of the season the chances seemed rather against a large yield. Frosts in the more northern latitudes during the closing days of the month, coming at a date earlier than usual and finding the crop short of its usual development, strengthened the apprehension that a considerable portion of the crop would be found unmerchantable in quality. The month of September, however, so far as temperature was concerned, was a complete reversal of the previous record of the season. Temperature rose very high, and as it was accompanied with less than the usual rainfall it gave a month of hot forcing weather, crowding late crops to ripening and compensating for the somewhat unfavorable character of the previous portion of the season. This compensation was noticeably marked in the great corn belt, where it was specially necessary, the excess over the normal monthly average ranging from 2.6° in the Ohio Valley to 5.8° in the upper Lake region.



UPPER MISSISSIPPI VALLEY.

The effect of the deficiency in rainfall was most marked in the upper Mississippi Valley, although the aggregate deficiency was greater in other districts. An explanation of this may be found in the fact that in this region the summer of 1890 was similarly dry, and the monthly deficiency continued from November of 1890 to September of the present year, with a very slight interruption in March and August. The damage was not wrought by the severity of the season's drought, but by the cumulative effect of its long continuance. The severe drought of 1890, which caused partial crop failure in the Missouri Valley, was followed during the present season by another deficient rainfall; but it was not a

continuous deficiency, the normal moisture supply being exceeded during the winter months and again in June. The effect of continued drought being broken, there was ample supply of rainfall for crop production, and the areas upon which the crops were shriveled last year, with an aggregate deficiency of rainfall of 5.85 inches during the growing season, made heavy yields of corn this year, with a deficiency during the same period of 3.79 inches. The proper distribution of rainfall, even more than the aggregate amount of precipitation, influences the rate of yield.



WESTERN GULF STATES.

A careful study of the meteorological peculiarities of 1890 and 1891 should throw some light upon some obscure problems of agricultural meteorology. A comparison of the condition averages of the two years, which forecast the crop results, will show in a very striking way the adverse character of the season of 1890 and the exceptionally favorable meteorological conditions of the past year. The statement of monthly averages for corn is as follows:

	July.	August.	September.	October.
1890	93.1	73.3	70.1	70.6
1891	92.8	90.8	91.1	92.5

The condition on the 1st of July was practically identical in the two years. It is always good at that date unless cold and wet spring weather has interfered with planting, germination, and early growth. Though maize can endure more heat and drought than most other agricultural

plants, the danger of long-continued absence of rainfall, especially in July and August, the season of development for this crop, is the greatest to which it is exposed. Note the sudden decline of condition in 1890, due mainly to drought, as indicated by the report of the 1st of August. The August weather intensified the injury, while the favorable influences of September at least prevented further decline and led to slightly more hopeful views in the formulation of the local estimates of October. The record of 1891, in sharp contrast to that of 1890, commencing with quite moderate evidence of early growth, showed that the crop had endured the ordeal of deficient moisture and fervent suns of July with a lowering of only two points, after which a steady improvement continued to October, and later through the autumn season so important in drying the grain and perfecting its quality. This has advanced a crop of medium status, in its germination and stalk growth, to a production above the average, or 27 bushels per acre, not the largest yield known, but one not often exceeded for the entire breadth. To indicate locally the differences of the two years the following statement of condition by States representing sections and including all of the commercial-surplus States, are given for each month:

States.	July.		August.		September.		October.	
	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.
New York	87	92	83	91	78	92	80	95
Virginia	97	94	92	95	91	95	92	97
Georgia	98	95	90	95	90	97	87	99
Texas	90	95	76	93	76	92	72	91
Tennessee	90	96	72	96	78	98	76	97
Kentucky	87	95	67	95	76	97	80	98
Ohio	85	93	66	93	56	95	60	97
Indiana	94	95	70	88	70	90	71	94
Illinois	97	96	71	88	68	88	72	92
Iowa	95	94	85	90	75	90	73	95
Missouri	93	88	72	87	77	88	80	86
Kansas	93	82	43	88	42	82	43	83
Nebraska	91	90	69	89	52	89	54	93

The strongest contrasts are presented by Kansas, where the July condition was 93 in 1890 and 82 in 1891, while at the close of the season the record stood 43 and 83, respectively, a fall of 50 points in 1890, and a rise of 1 in 1891. The October record emphasizes the differences of the two seasons, opposing varied degrees of depression in 1890 to relatively high condition in 1891.

A noticeable and unusual peculiarity of the year is the almost universal occurrence of medium or large production. Ordinarily, a large yield of one crop is offset by a diminished product of another. The summer crops may be generally good, and the winter grains and grasses seriously injured by the severity of the winter. A comparative failure in wheat has often occurred in a year of abundance of corn, and *vice versa*. In a year like 1881 nearly all crops were poor, but not equally diminished. The present year is an exception of nearly universal abundance. The record of condition of winter wheat in 1890 and 1891 makes a contrast quite as sharp as that made by that of maize, which is distinctly a summer crop. It is as follows:

	April.	May.	June.	July.	September.*
1890	81	80	78.1	76.2	75.5
1891	96.9	97.9	96.6	96.2	96.7

* Or condition at harvesting.

There could scarcely be a sharper contrast. The crop of 1890 was in very low condition at the close of winter, and grew worse through the season. That of the present year remained at almost absolutely the same high and nearly perfect figure from start to finish. In the one the damage was mainly done by winter conditions; in the other there was no material injury from climatic causes either in winter or summer.

The oats crop also illustrates the contrasts of those two seasons, showing a constant improvement during the past season, and a regular and rapid decline during the season of 1890, though the June condition of the crop of 1890 was decidedly better than that of the present crop. The figures are as follows:

	June.	July.	August.	September.*
1890	89.8	81.6	70.1	64.4
1891	85.1	87.6	89.5	90.7

*Or time of harvesting.

While the tables of rainfall and temperature show some of these contrasts in a general way, it will be found, upon sufficient meteorological investigation, that the *distribution* of rainfall is a larger factor in crop production than mere quantity, and that a combination of excessive moisture and great heat for a period of two days often does more damage to grain and fruit than a drought of two months. The record of averages is useful, but it can not explain all the mysteries still unsolved in agricultural meteorology.

A BRIEF OF CROP RECORDS.

Weather conditions were generally favorable in the preparation of the seed bed for winter grains. The soil was easily worked, except upon limited areas, and sowing was but little interrupted. On the Atlantic coast it was delayed a little by occasional rains, but the desired area was put in and the autumn rains secured prompt germination and good fall growth. Throughout the central West, especially, seeding was accompanied and followed by gentle rains sufficient to properly pack the earth and insure thrifty growth before the advent of cold weather. In portions of Missouri and Kansas and in Nebraska seeding was prosecuted under less favorable circumstances, the severe drought of last summer interfering with the preparation of the bed, delaying sowing, and making germination late. It was broken, however, in season to secure good though late growth, and the mild winter was sufficient to offset the disadvantage of a late start, making spring condition so good that in many districts correspondents declared it the best ever known. California enjoyed a favorable fall and winter season, sufficient moisture in the drier districts, with no excess in the valleys which occasionally suffer from excessive rainfall. A dry seed bed in Oregon was moistened early enough to secure good stand and growth, and the mild winter further stimulated condition.

The favorable meteorological conditions which everywhere prevailed during autumn and early winter sent the plant into winter quarters well developed, and the mild weather of January and February in many districts induced continuous winter growth. Less than the usual degree of protection by snowfall was afforded, but much less than usual was required, and the covering was present when needed. Brown and

bare spots were not frequently present even in the most exposed situations, and many correspondents noted with surprise that on areas liable to damage from winter killing not even the tips of the blades were discolored.

As spring advanced the crop not only kept its promising status, but continued to improve. Some frost and deficient moisture threatened it in the Middle States, causing some anxiety of growers, which was happily dispelled before a serious deterioration occurred. The July returns continued, and confirmed the most favorable record of winter grains ever made in any season since the Department statistical service was organized.

Spring wheat, like winter, was grown on an increased area. The partial failure of the previous year, and the advance in price, with possibly an expectation of a decreasing world's production, stimulated the seeding of a larger breadth. This careful watch for changes of area that will affect price, this outlook for the best pecuniary results of crop distribution, is precisely what may be expected to prevent any marked decline in wheat-growing. The American farmer is far more likely to hinder progress and limit profits by too precipitate change than by a wise forecast and patient waiting for more profitable results that require time for development. The wheat crop as a whole, enlarged nearly 9 per cent in the preliminary estimate, is found to be fully 10 per cent more than the reduced area of the previous year, though less than 5 per cent more than the breadth of 1889.

The soil of much of the spring-wheat region was somewhat too dry for early seeding and prompt germination. A good stand was not secured in Wisconsin by reason of drought, and that which germinated was not in good condition at first, while wheat on moist soils looked fairly well. In eastern Minnesota there was also some deterioration from drought, which was not long continued, being followed by refreshing rains in season to make a moderate June record. In South Dakota the early spring was more favorable than in North Dakota. In the latter part of May this condition was reversed, and the growers of North Dakota rejoiced in refreshing showers, while those of South Dakota saw the bright prospect impaired by deficiency of moisture. Fears of impairment in Nebraska were dissipated by seasonable rains. The soil was also somewhat too dry in Washington, but improvement followed there also in May. During the month of June the condition improved everywhere except in Wisconsin. Improvement continued in July in all States except Washington, where hot winds wrought injury in certain districts. The August report indicated "a product of wheat but little short of the capabilities of the soil under the most favorable conditions." The harvest confirmed this estimate as to a large part of the area, with some discount for impairment in South Dakota and Washington.

The corn crop was somewhat late; drought in early spring and cool weather in May delayed planting to some extent. June was warm, stimulating growth, and putting the crop in good condition at the date of the July report. In portions of Kentucky and Ohio rains delayed cultivation. Some replanting was necessary to fill gaps in the stand. In Kansas and Nebraska excessive rains in June washed the fields and prevented proper cultivation. The semi-arid belt, formerly the "Great American Desert," received a bountiful supply of moisture, and became green with a vigorous growth of maize. The month of July brought generally abundant moisture, cool weather, good color, but not so uniformly rapid growth and advanced development. On the 1st of Sep-

tember the crop was reported late in earing from cool nights, with entire absence of frost except in certain northern districts. The month of September was remarkable for high temperature, supplementing the deficient maturity of maize in August and ripening thoroughly the latest corn that was expected to make a crop. Fine weather continued in October, still further advancing the quality of the crop, which became one above the average in both quality and quantity.

Potatoes early gave promise of a good crop, condition averaging 95.3 against 91.7 in July of 1891. While the decline in 1890 was rapid and serious, resulting in a very low yield, the condition has been well sustained this year, considering the liability to rot in the latter part of the season. The comparison of condition is as follows:

	July.	August.	September.	October.
1890	91.7	77.4	65.7	61.7
1891	95.3	96.5	94.8	91.3

The tendency to rot exhibited early in certain districts was overborne by the fine weather and high temperature of September, and the loss from this cause was local and confined mostly to the Eastern and Middle States, making little show in reduction of the aggregate yield. The result is the largest crop ever reported.

The comparative failure of the oats crop in 1890, from the effects of the drought and the *aphis* combined, was somewhat discouraging, tending to prevent increase of area. The crop, however, had nearly the breadth of that of 1890, and shared in the favorable influences of the season, making a product second only to the largest ever grown.

The barley crop has increased largely in acreage, and has made a good yield, making the largest aggregate ever grown in this country. Rye and buckwheat have also shared the favoring influences of the season, made excellent growth, matured seasonably, and returned bountiful harvests as a reward of the farmers' labors.

The production of sugar cane is gradually increasing. An enlargement of area has been made this year in Louisiana, and a medium product is expected. The October report stated that plant cane was not improving, though stubble cane was excellent, and with the increased acreage would probably make the production equal to that of 1890. The returns of November were more favorable, and improvement in condition was noted.

The beet-sugar industry has been signalized by the establishment of new plants for manufacture. The results in production will be ascertained and made public as soon as practicable.

The hay crop is one of relatively large yield. Frosts in May reduced condition along the Atlantic coast, and deficient moisture shortened the crop in the lighter soils of this region. The product of clover hay was smaller than usual, owing more to the condition of old sod injured by severe winters than on account of winter killing of the past season. In Michigan and Wisconsin the dry weather made a very light crop, which was secured in excellent condition. The upper portion of the Ohio Valley had only a medium product, Indiana and Illinois reported a good average, and the States west of the Mississippi a comparatively heavy production. In the South a good crop was secured on an enlarged area.

The yield of tobacco is somewhat above the average, and with the

breadth grown insures sufficient supply for the needs of domestic consumption and for any probable demand for exportation. The seed-leaf districts already feel the effect of the lessened competition of Sumatra leaf since the present customs law went into effect, and the status of the industry, especially in the Connecticut Valley, is much better than during recent years. Prices have advanced, a hopeful feeling is apparent, and the indications are that an increased breadth will be planted next year to supply the demand of the home market.

The June return of fruit was unusually favorable. Some impairment of condition and reduction of expectation occurred during the month. In the Eastern and Middle States the prospect was more favorable for summer and fall varieties of apples than for winter fruit. In New York and Pennsylvania the dropping of fruit early in the season was unusually heavy. Late spring frosts, the bane of fruit-growing in this country, destroyed the blossoms or the tender fruit in many districts, either partially or wholly. Ohio and Michigan suffered severely from May frosts while the trees were in bloom, reducing the crop heavily. West of the Mississippi the apple crop was generally a good one.

The final result, on the whole, was a crop of medium yield, abundant in comparison with last year, somewhat deficient in the great centers of commercial supply, especially Michigan and northern Ohio, and not quite an average in western New York; medium in the Eastern and Middle States, and large generally in the Missouri Valley, the valleys of the mountains, and the Pacific coast region.

There was a large crop of peaches in the commercial as well as farm orchards, distributed quite generally, with a better condition than apples through the season.

The subtropical and tropical fruits made good yields, as a rule. These branches of fruit culture are constantly enlarging, making steady inroads on the imports of foreign citrus fruits, prunes, raisins, and other dried fruits. In California this progress is wonderful, and it is scarcely less so in Florida. A very rapid development in Louisiana orange-growing is manifest.

A large increase of area in flax is reported. The increase is entirely west of the Mississippi and confined almost exclusively to the States of Minnesota, Iowa, Kansas, Nebraska, and the Dakotas. About 97 per cent of the crop, which is grown almost exclusively for seed, is produced west of the Mississippi, whereas the census of 1880 showed that 65 per cent of the total production was east of that river. An investigation indicates the occupancy of nearly two million acres in that crop; the results of recent investigation show an acreage of 1,927,293 acres and a product of 15,455,272 bushels, or an increase of about 50 per cent over that of 1889.

The fiber is not extensively used. In some of the more eastern districts there are scattered mills which manufacture a coarse tow for upholstering purposes. Formerly the stalk was burned or left to rot after the seed was taken, and this is still the case in certain districts. Now it is oftener stacked, like straw, and cattle are allowed to feed upon it, which they do with apparent relish.

Experiments have been made in growing a fine fiber, with good success when undertaken by persons familiar with growing and dressing the fiber in foreign countries.

The wool product of the year shows a larger weight of fleece than usual, from better care and a favorable winter for growth and health of the flocks. The estimated product is 285,000,000 pounds from the spring and fall fleeces and from the sheep and lambs slaughtered during the

year. The price of wool has been low throughout the world, yet the decline has been less in this than in other countries, and farmers are encouraged to expect a steady and strong demand for wool in the future.

THE MAIN CEREAL CROPS.

CORN.

There was estimated last year a loss of acreage, from abandonment in consequence of the severity of the drought in certain sections, of 6,000,000 acres of the breadth planted. That loss was substantially made good in the planting of the present year, the area harvested being placed at 76,204,515 acres, producing 2,060,154,000 bushels. The total for corn has only been exceeded once before, in 1889, when the estimated product was 2,112,892,000 bushels. The yield per acre is the same as in 1889, 27 bushels, which is a bushel more than the accepted average of former periods and about 3 bushels more than the average of the last ten years. This yield will assure those who view statistics with nearsighted vision that the fertility of our cornfields is not exhausted, and that other causes of crop shortage must be considered in the fluctuations of yield that are the most noticeable feature of crop records.

The decadence of corn-growing in Illinois, with the constant tendency to diversification in progress there, and the prominence of maize in Iowa, where the estimates make an area of 9,560,716 acres and a product of 350,878,000 bushels, are noticeable changes in crop distribution. The order of prominence this year is Iowa, Illinois, Missouri, Nebraska, Kansas, Indiana, and Ohio in the corn surplus belt.

Fifty years ago corn was the great American crop, and it must long stand at the front in our arable culture. In 1840 the product was officially stated at 377,531,875 bushels. The present crop is nearly six times as large, though the population is less than four times as much as in 1840. It is remarkable that this production has so far outdistanced the movement of population, but the fact is due to its various uses in every branch of farm feeding and in meat production. The South was then the center of corn-growing, and Tennessee the first State in rank in its production, followed in order by Kentucky, Virginia, Ohio, Indiana, North Carolina, and Illinois. The movement of this center has been northward and westward, passing from Ohio to Illinois, and now beyond the Mississippi to Iowa. The estimates for 1891 are as follows:

Corn, 1891.

States and Territories.	Acres.	Bushels.	Value.
Maine	29,526	1,107,000	$885,780
New Hampshire	37,246	1,333,000	1,026,723
Vermont	57,638	2,144,000	1,629,542
Massachusetts	54,134	2,138,000	1,667,869
Rhode Island	13,015	450,000	355,542
Connecticut	58,663	2,112,000	1,605,020
New York	694,328	22,080,000	14,572,556
New Jersey	360,915	12,343,000	8,023,140
Pennsylvania	1,397,211	46,527,000	26,520,462
Delaware	232,061	5,105,000	2,807,938
Maryland	740,425	18,881,000	10,006,844
Virginia	2,004,360	39,486,000	19,742,946
North Carolina	2,672,054	37,676,000	21,852,057
South Carolina	1,607,755	18,650,000	13,054,971
Georgia	3,100,745	37,829,000	26,102,071
Florida	496,342	5,460,000	4,367,810

Corn, 1891—Continued.

States and Territories.	Acres.	Bushels.	Value.
Alabama	2, 539, 011	32, 245, 000	$20, 314, 627
Mississippi	1, 951, 651	29, 665, 000	17, 205, 755
Louisiana	1, 082, 392	18, 725, 000	11, 235, 229
Texas	3, 622, 327	70, 635, 000	38, 849, 457
Arkansas	2, 062, 575	42, 455, 000	19, 529, 111
Tennessee	3, 636, 664	82, 552, 000	35, 497, 477
West Virginia	691, 885	18, 888, 000	9, 822, 000
Kentucky	2, 759, 832	82, 795, 000	33, 117, 984
Ohio	2, 940, 368	94, 092, 000	38, 577, 628
Michigan	1, 055, 363	31, 133, 000	14, 943, 940
Indiana	3, 712, 380	123, 622, 000	46, 976, 457
Illinois	7, 011, 336	234, 880, 000	86, 905, 510
Wisconsin	1, 113, 042	29, 718, 000	13, 076, 017
Minnesota	814, 556	21, 586, 000	8, 418, 436
Iowa	9, 560, 716	350, 878, 000	105, 263, 483
Missouri	6, 796, 318	203, 210, 000	77, 219, 765
Kansas	5, 314, 337	141, 893, 000	48, 243, 551
Nebraska	4, 762, 840	167, 052, 000	43, 589, 512
California	161, 470	5, 571, 000	3, 955, 208
Oregon	9, 613	260, 000	184, 281
Colorado	43, 397	933, 000	494, 509
North Dakota	38, 922	701, 000	280, 238
South Dakota	934, 130	21, 018, 000	7, 356, 274
New Mexico	57, 415	1, 051, 000	756, 500
Utah	35, 527	675, 000	405, 008
Total	76, 204, 515	2, 060, 154, 000	836, 439, 228

For comparative purposes the record of former corn crops is presented. An examination of this record will disclose a range of yield from 18.6 bushels per acre in 1881 to 27.6 bushels in 1880. The low yields of 1881, 1883, 1886, and 1887 were due to drought. The absence of severe drought in most of the period from 1870 to 1889 accounts for the larger yields of that period. The past decade began and ended with a yield above the average. This record is as follows:

Years.	Total production.	Total area of crop.	Total value of crop.	Average value per bushel.	Average yield per acre.	Average value per acre.
	Bushels.	*Acres.*		*Cents.*	*Bushels.*	
1880	1, 717, 434, 543	62, 317, 842	$679, 714, 499	39. 6	27. 6	$10. 91
1881	1, 194, 916, 000	64, 262, 025	759, 482, 170	63. 6	18. 6	11. 82
1882	1, 617, 025, 100	65, 659, 545	783, 867, 175	48. 5	24. 6	11. 94
1883	1, 551, 066, 895	68, 301, 889	658, 051, 485	42. 4	22. 7	9. 63
1884	1, 795, 528, 000	69, 683, 780	640, 735, 560	35. 7	25. 8	9. 19
1885	1, 936, 176, 000	73, 130, 150	635, 674, 630	32. 8	26. 5	8. 69
1886	1, 665, 441, 000	75, 694, 208	610, 311, 000	36. 6	22. 0	8. 06
1887	1, 456, 161, 000	72, 392, 720	646, 106, 770	44. 4	20. 1	8. 93
1888	1, 987, 790, 000	75, 672, 763	677, 561, 580	34. 1	26. 3	8. 95
1889	2, 112, 892, 000	78, 319, 651	597, 918, 829	28. 3	27. 0	7. 63
Total	17, 034, 430, 538	705, 434, 573	6, 689, 423, 698			
Average for ten years—1880 to 1889	1, 703, 443, 054	70, 543, 457	668, 942, 370	39. 3	24. 1	9. 48
Average for ten years—1870 to 1879	1, 184, 486, 954	43, 741, 331	504, 571, 048	42. 6	27. 1	11. 54
1890	1, 489, 970, 000	71, 970, 763	754, 433, 451	50. 6	20. 7	10. 48
1891	2, 060, 154, 000	76, 204, 515	836, 439, 228	40. 6	27. 0	10. 98
Total	3, 550, 124, 000	148, 175, 278	1, 590, 872, 679			
Average for two years—1890 to 1891	1, 775, 062, 000	74, 087, 639	795, 436, 340	44. 8	24. 0	10. 74

The following table presents the record of exports of maize during the past twenty years, and shows that only about 1 bushel in 25 is

exported in the form of grain, and that the exportation depends on the home price and has little influence in making home values:

Production and export of corn.

Years.	Production.	Exports.	Exportation.	Years.	Production.	Exports.	Exportation.
	Bushels.	*Bushels.*	*Per cent.*		*Bushels.*	*Bushels.*	*Per cent.*
1870	1,094,255,000	10,673,553	1.0	1882	1,617,025,100	41,655,653	2.6
1871	991,898,000	35,727,010	3.6	1883	1,551,066,895	46,258,606	3.0
1872	1,092,719,000	40,154,374	3.7	1884	1,795,528,000	52,876,456	2.9
1873	932,274,000	35,985,834	3.9	1885	1,936,176,000	64,829,617	3.3
1874	850,148,500	30,025,036	3.5	1886	1,665,441,000	41,368,584	2.5
1875	1,321,069,000	50,910,532	3.9	1887	1,456,161,000	25,360,869	1.7
1876	1,283,827,500	72,652,611	5.7	1888	1,987,790,000	70,841,673	3.6
1877	1,342,558,000	87,192,110	6.5	1889	2,112,892,000	103,418,709	4.9
1878	1,388,218,750	87,884,892	6.3	1890	1,489,970,000	32,041,529	2.2
1879	1,754,591,676	99,572,329	5.7				
1880	1,717,434,543	93,648,147	5.5				
1881	1,194,916,000	44,340,683	3.7	Annual average	1,455,998,094	55,591,372	3.8

WHEAT.

This country has led the van in wheat-growing for more than a decade and a half. France stands next, followed by India and Russia. This year's crop of the United States is the largest ever grown in any country, and the largest rate of yield ever recorded since the organization of this Department.

The population of the country is between three and four times as large as in 1840; the wheat crop of 1891 is seven times as large as at that date. Four and one-third bushels for each unit of population then; nine and one-fifth bushels now. There has been much written for twenty years past, the result of crude generalizing from agricultural data, to the effect that wheat-growing is declining, moving westward, abandoned in the old States and precociously developing in the new. The decline of flour-milling in Rochester is cited as evidence of inability of western New York farmers to produce wheat. Ohio, Michigan, Illinois, Dakota, and the Pacific coast are made almost simultaneously landmarks of progress in wheat-growing and monuments recording its decay. A little thought, a review of the whole field of fact, will show the kaleidescopic changes incident to the work of diversifying and molding our primitive agriculture. Western New York produces as much wheat as ever, and fruit and vegetables and other products of tenfold greater aggregate value. So do Ohio and Michigan. Wheat is grown no less, but other products much more. Simply, wheat has passed out of the category of exclusive cropping, the primitive stage of agricultural development in which no real progress is possible.

The one point totally unknown to pessimists in breadstuffs is the possibility of an increase in yield per acre. The difference between the past season and the present is an advance in yield of almost 50 per cent, and an aggregate product, with the aid of some increase of area, of more than two hundred million bushels. The yield is now but 15.3, and should be made 20 at least by improved cultivation and judicious fertilization. Cases of yield at the rate of 50 bushels per acre are reported to this division by individual farmers, more at 30 to 40, and numerous records of 25 to 30 are made in New England, the Ohio Valley, and throughout the entire wheat belt, in some instances even in the South, where State

yields usually range from 6 to 12, in some instances 15 bushels. In the best wheat districts the average this year approximates 20 bushels, and in some States exceeds that figure. Returns from individuals of our special list of 125,000 farmers make an aggregate of more than twenty-two million bushels actually grown by them on nearly a million and a quarter acres, averaging an actual yield of 18 bushels per acre. This fact indicates the possibilities of increase of yield. The acreage cultivated the present year, if brought to a yield of 25 bushels per acre, equal to that of the sands of Holland and less than that of the gravelly clays of England, would produce a thousand million bushels of wheat. It will never be done while our land is so cheap, but can be done in the future, and should be. Our low usual rate of yield is simply a disgrace to American agriculture, but it will continue only while that agriculture remains in its primitive stage.

The following table gives the area, product, and value of wheat by States, as estimated at the close of the year by the Statistician:

Wheat, 1891.

States and Territories.	Acres.	Bushels.	Value.
Maine	41,017	669,000	$735,435
New Hampshire	8,972	148,000	170,244
Vermont	19,673	344,000	392,477
Connecticut	1,838	31,000	32,808
New York	640,540	10,633,000	10,632,964
New Jersey	138,833	2,124,000	2,209,111
Pennsylvania	1,337,437	20,864,000	20,864,017
Delaware	97,634	1,250,000	1,249,715
Maryland	540,494	8,107,000	8,107,410
Virginia	850,073	7,651,000	7,650,657
North Carolina	731,573	4,975,000	5,074,190
South Carolina	180,395	992,000	1,091,390
Georgia	309,743	2,323,000	2,555,380
Alabama	281,327	2,251,000	2,475,678
Mississippi	61,965	483,000	483,327
Texas	536,247	6,435,000	5,598,419
Arkansas	232,940	2,236,000	2,012,602
Tennessee	1,198,553	11,626,000	10,812,147
West Virginia	332,295	3,423,000	3,285,733
Kentucky	1,037,870	13,181,000	11,862,854
Ohio	2,662,603	45,531,000	41,888,070
Michigan	1,606,670	30,205,000	27,486,910
Indiana	2,917,518	52,807,000	45,414,085
Illinois	1,945,832	35,025,000	29,771,230
Wisconsin	966,128	13,043,000	10,955,892
Minnesota	3,143,917	55,333,000	43,159,692
Iowa	1,803,036	27,586,000	22,345,025
Missouri	1,892,082	25,732,000	20,585,852
Kansas	3,539,760	54,866,000	40,052,384
Nebraska	1,205,350	18,080,000	13,198,583
California	2,815,007	36,595,000	34,765,336
Oregon	692,055	13,149,000	11,571,160
Nevada	20,338	372,000	323,801
Colorado	100,832	2,037,000	1,486,868
Arizona	27,227	395,000	296,094
North Dakota	2,927,274	52,105,000	36,473,834
South Dakota	1,954,883	29,714,000	21,394,240
Idaho	90,531	1,811,000	1,520,921
Montana	92,803	1,856,000	1,559,090
New Mexico	93,328	1,073,000	880,083
Utah	136,764	2,393,000	1,795,028
Washington	698,040	12,216,000	9,161,775
Wyoming	5,500	110,000	90,200
Total	39,916,897	611,780,000	513,472,711

The following table presents the records of the past decade, in comparison with the averages of the preceding decade. Unlike corn, wheat presents nearly the same average of yield as in the ten years of 1870, and for two years of a new decade a higher rate than has been heretofore, due to the abnormal yield of the present year. It will be seen

that the aggregate value is far above that of any previous year, and $142,000,000 more than the average of the last decade:

Years.	Total production.	Total area of crop.	Total value of crop.	Average value per bushel.	Average yield per acre.	Average value per acre.
	Bushels.	*Acres.*		*Cents.*	*Bushels.*	
1880	498, 549, 868	37, 986, 717	$474, 201, 850	95. 1	13. 1	$12. 48
1881	383, 280, 090	37, 709, 020	456, 880, 427	119. 2	10. 2	12. 12
1882	504, 185, 470	37, 067, 194	444, 602, 125	88. 2	13. 6	11. 99
1883	421, 086, 160	36, 455, 593	383, 649, 272	91. 1	11. 6	10. 52
1884	512, 765, 000	39, 475, 885	330, 862, 260	64. 5	13. 0	8. 38
1885	357, 112, 000	34, 189, 246	275, 320, 390	77. 1	10. 4	8. 05
1886	457, 218, 000	36, 806, 184	314, 226, 020	68. 7	12. 4	8. 54
1887	456, 329, 000	37, 641, 783	310, 612, 960	68. 1	12. 1	8. 25
1888	415, 868, 000	37, 336, 138	385, 248, 030	92. 6	11. 1	10. 32
1889	490, 560, 000	38, 123, 859	342, 491, 707	69. 8	12. 9	8. 98
Total	4, 496, 953, 588	372, 791, 619	3, 718, 095, 041			
Average, ten years, 1880 to 1889	449, 695, 359	37, 279, 162	371, 809, 504	82. 7	12. 1	9. 97
Average, ten years, 1870 to 1879	312, 152, 728	25, 187, 414	327, 407, 258	104. 9	12. 4	13. 00
1890	399, 262, 000	36, 087, 154	334, 773, 678	83. 8	11. 1	9. 28
1891	611, 780, 000	39, 916, 897	513, 472, 711	83. 9	15. 3	12. 86
Total	1, 011, 042, 000	76, 004, 051	848, 246, 389			
Average, two years, 1890 and 1891	505, 521, 000	38, 002, 026	424, 123, 195	83. 9	13. 3	11. 16

OATS.

The area of oats has been decreased by the semifailure of the previous crop, due to drought and the *aphis*, yet the higher rate of yield has brought the crop nearly up to the aggregate production of 1889. The estimates of the year are as follows:

Oats, 1891.

States and Territories.	Acres.	Bushels.	Value.
Maine	99, 601	3, 446, 000	$1, 550, 788
New Hampshire	31, 359	1, 098, 000	504, 880
Vermont	107, 657	4, 037, 000	1, 655, 227
Massachusetts	23, 275	768, 000	360, 995
Rhode Island	6, 741	226, 000	106, 137
Connecticut	38, 239	1, 147, 000	516, 227
New York	1, 329, 984	41, 894, 000	15, 919, 908
New Jersey	138, 706	3, 884, 000	1, 553, 507
Pennsylvania	1, 239, 101	33, 704, 000	12, 470, 312
Delaware	24, 078	489, 000	190, 625
Maryland	111, 944	2, 127, 000	808, 236
Virginia	618, 404	6, 617, 000	2, 712, 938
North Carolina	538, 938	5, 120, 000	2, 611, 155
South Carolina	385, 361	4, 085, 000	2, 491, 744
Georgia	618, 626	7, 238, 000	4, 342, 754
Florida	52, 469	598, 000	370, 851
Alabama	405, 344	5, 188, 000	3, 113, 042
Mississippi	325, 793	3, 747, 000	2, 173, 040
Louisiana	51, 542	634, 000	329, 663
Texas	652, 059	15, 975, 000	7, 508, 460
Arkansas	299, 708	4, 945, 000	2, 076, 976
Tennessee	614, 483	5, 960, 000	2, 384, 194
West Virginia	137, 844	2, 385, 000	953, 880
Kentucky	441, 894	8, 175, 000	3, 024, 764
Ohio	911, 292	28, 523, 000	9, 412, 735
Michigan	931, 677	30, 280, 000	9, 689, 441
Indiana	895, 067	21, 034, 000	6, 730, 904
Illinois	3, 068, 930	111, 095, 000	31, 106, 674
Wisconsin	1, 481, 919	49, 348, 000	13, 817, 413
Minnesota	1, 425, 080	52, 015, 000	14, 044, 163
Iowa	2, 795, 003	102, 577, 000	26, 669, 919

Oats, 1891—Continued.

States and Territories.	Acres.	Bushels.	Value.
Missouri	1, 158, 398	27, 568, 000	$7, 994, 642
Kansas	1, 237, 740	37, 132, 000	10, 025, 694
Nebraska	1, 368, 977	48, 599, 000	11, 177, 697
California	84, 786	2, 416, 000	1, 449, 841
Oregon	233, 037	7, 341, 000	3, 009, 673
Colorado	109, 790	3, 579, 000	1, 360, 079
North Dakota	496, 926	16, 647, 000	4, 328, 225
South Dakota	724, 092	23, 388, 000	5, 847, 043
Idaho	37, 898	1, 326, 000	663, 215
Montana	94, 747	3, 648, 000	1, 750, 925
New Mexico	16, 330	359, 000	197, 593
Utah	39, 646	1, 288, 000	541, 168
Washington	177, 466	6, 744, 000	2, 764, 920
Total	25, 581, 861	738, 394, 000	232, 312, 267

The following table shows a marvelous advance in production of oats during the past decade, an increase of area of more than 50 per cent. The present rate of yield is the largest in that period, and exceeds the average rate of yield of the decade from 1870.

Years.	Total production.	Total area of crop.	Total value of crop.	Average value per bushel.	Average yield per acre.	Average value per acre.
	Bushels.	*Acres.*		*Cents.*	*Bushels.*	
1880	417, 885, 380	16, 187, 977	$150, 243, 565	36. 0	25. 8	$9. 28
1881	416, 481, 000	16, 831, 600	193, 198, 970	46. 4	24. 7	11. 48
1882	488, 250, 610	18, 494, 691	182, 978, 022	37. 5	26. 4	9. 89
1883	571, 302, 400	20, 324, 962	187, 040, 264	32. 7	28. 1	9. 20
1884	583, 628, 000	21, 300, 917	161, 528, 470	27. 7	27. 4	7. 58
1885	629, 409, 000	22, 783, 630	179, 631, 860	28. 5	27. 6	7. 88
1886	624, 134, 000	23, 658, 474	186, 137, 930	29. 8	26. 4	7. 87
1887	659, 618, 000	25, 920, 906	200, 699, 790	30. 4	25. 4	7. 74
1888	701, 735, 000	26, 998, 282	195, 424, 240	27. 8	26. 0	7. 24
1889	751, 515, 000	27, 462, 316	171, 781, 008	22. 9	27. 4	6. 26
Total	5, 843, 958, 390	219, 963, 755	1, 808, 664, 119			
Average, ten years, 1880 to 1889	584, 395, 839	21, 996, 376	180, 866, 412	30. 9	26. 6	8. 22
Average, ten years, 1870 to 1879	314, 441, 178	11, 076, 822	111, 075, 223	35. 3	28. 4	10. 03
1890	523, 621, 000	26, 431, 369	222, 048, 486	42. 4	19. 8	8. 40
1891	738, 394, 000	25, 581, 861	232, 312, 267	31. 5	28. 9	9. 08
Total	1, 262, 015, 000	52, 013, 230	454, 360, 753			
Average, two years, 1890 to 1891	631, 007, 500	26, 006, 615	227, 180, 377	36. 0	24. 3	8. 74

DISTRIBUTION AND CONSUMPTION OF BREADSTUFFS.

CORN.

The crop of 1890 was the smallest reported in nine years, in proportion to population, as the previous one was the largest. The reduction is about 30 per cent, from 2,113,000,000 to 1,490,000,000. It is not strange that the law of supply and demand, which even speculators can not nullify, should have raised the average price, as established by the December returns, from 28.3 cents to 50.6, nor that the former rate should be the lowest in nine years, or the latter the highest.

This rise in price was not brought about by the wisdom of growers, for a larger area was planted in 1890, in the hope of a still larger harvest. But the forces of nature were adverse, and the resulting disaster was a blessing in disguise.

The comparison of stock on hand and quantity consumed on the 1st of March is as follows:

March 1—	Product of previous year.	On hand March 1.	Per cent.	Consumed or distributed.
	Bushels.	*Bushels.*		*Bushels.*
1883	1,617,000,000	587,000,000	36.3	1,030,000,000
1884	1,551,000,000	512,000,000	33	1,039,000,000
1885	1,795,000,000	675,000,000	37.6	1,120,000,000
1886	1,936,000,000	773,000,000	39.9	1,163,000,000
1887	1,665,000,000	603,000,000	36.2	1,062,000,000
1888	1,456,000,000	508,000,000	34.9	948,000,000
1889	1,988,000,000	787,000,000	39.6	1,201,000,000
1890	2,113,000,000	970,000,000	45.9	1,143,000,000
1891	1,490,000,000	542,000,000	36.4	948,000,000

The States of the Western group have consumed 66.2 per cent of the product, instead of 53.7 per cent last March. After the small crops of 1883 and 1887 the proportion consumed was slightly larger than the present percentage. The quantity reported as consumed or distributed is much less than that returned a year ago, though it is a little more than the consumption three years ago, after the year of drought. A decline of 171,000,000 bushels in the amount handled in the first six months after harvest in the Western group of States is a sharp reminder of scarcity, economy in use, and high price of maize, which has sent to market millions of half-fattened swine, causing a temporary abundance and low price of pork, which must be followed by a sharp advance after the present plethora of pork is reduced. For the same reason the country has been feeding upon Texas and plains beef, grass fed, and the average quality of high-grade beef, corn fed, has suffered depreciation.

The consumption of the States of the Middle group is more uniform, and the proportion advanced but little in comparison with that of the previous crop. The Eastern States and Pacific coast States have so little production that the figures are of little practical consequence. Next to the Western group the Southern States are most important. Their consumption is always a relatively small percentage of the crop at this date. This year it is 56.0 per cent; last year, 53.5 per cent. The proportions are as follows:

Sections.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
New England	70.2	66.2	62.9	61.6	63.3	65.4	66.5	66.4	67.7
Middle	62.6	68.2	63.4	59.3	61.8	65.6	62.0	59.9	62.3
Southern	56.5	58.6	58.6	54.6	58.1	55.5	55.7	53.5	56.0
Western	66.2	69.3	63.3	61.6	65.6	69.6	61.4	53.7	66.2
Pacific	74.6	70.7	60.4	68.4	70.5	78.3	75.1	71.4	73.5
Nevada, Colorado, and Territories	65.0	70.2	65.5	63.3	67.0	59.5	68.5	70.0	74.1

Turning from distribution to stocks on hand, we have about 428,000,000 bushels less than last March, a reduction of 44 per cent. The Western and Southern groups have 19 out of every 20 bushels of these stocks. The table is as follows:

Sections.	1888.		1889.		1890.		1891.	
	Bushels.	*P. ct.*	*Bushels.*	*P. ct.*	*Bushels.*	*P. ct.*	*Bushels.*	*P. ct.*
New England	3,177,620	34.6	2,304,580	33.5	2,873,780	33.6	2,709,930	32.3
Middle	28,595,170	34.4	31,759,040	38.0	30,603,350	40.1	26,566,520	37.7
Southern	187,825,040	44.5	182,670,430	44.3	199,408,040	46.5	164,036,740	44.0
Western	278,119,160	30.4	562,963,360	38.6	730,448,050	46.3	343,849,430	33.8
Pacific	1,061,960	21.7	1,112,310	24.9	1,321,250	28.6	1,212,870	26.5
Nevada, Colorado, and Territories	9,494,560	40.5	6,672,340	31.5	5,284,010	30.0	3,797,760	25.9
Total	508,273,510	34.9	787,482,060	39.6	969,938,480	45.9	542,173,250	36.4

In considering the question of commercial supply it is not necessary to regard the stocks of any States except seven, known as the corn-surplus States, as little is ever drawn into the channels of general trade from any other states. A marked peculiarity of the following statement is the scarcity of corn in Kansas and Nebraska, the region in which we hear so much of its use as fuel. The record of 290,000,000 bushels in the surplus States, where there were 667,000,000 last year, indicates the scarcity and explains the necessity of high prices. Nearly a third is in Iowa, and most of the remainder in Illinois and Missouri.

States.	1888.		1889.		1890.		1891.	
	Bushels.	*P. ct.*	*Bushels.*	*P. ct.*	*Bushels.*	*P. ct.*	*Bushels.*	*P. ct.*
Ohio	22,139,100	30	38,137,380	41	37,360,260	42	19,104,040	29
Indiana	19,992,000	28	50,191,200	40	47,995,200	45	24,927,000	28
Illinois	43,734,800	31	114,004,600	41	124,380,000	48	63,731,640	34
Iowa	62,390,680	34	114,075,120	41	167,983,680	48	86,002,430	37
Missouri	39,465,720	28	72,929,880	36	102,855,270	47	63,124,200	36
Kansas	18,371,280	24	52,201,380	33	117,848,920	49	15,475,320	28
Nebraska	34,465,500	37	57,686,800	40	68,789,780	46	17,699,200	32
Total	240,559,080	30.8	499,226,360	39.0	667,213,110	47.2	290,063,830	33.7

Though only about one-half of the reserve is in these States, scarcely any of the other one-half is commercially available. The failure in Ohio and Indiana and in the Missouri Valley limits to an unusually narrow district the search for commercial maize supplies.

DISTRIBUTION.

The estimated distribution beyond county lines is necessarily small. The reduction in exports is so far this year more than 50 per cent; the reduction in Eastern use of Western corn is very heavy, and shipments to adjoining counties and States for feeding purposes very much curtailed, so that the estimated quantity intended for outside consumption is only 188,000,000 bushels instead of 384,000,000 bushels reported last year. The statement in detail of crop stocks on hand and local consumption is thus stated:

States and Territories.	Crop of 1890.	Stock on hand March 1, 1891.		Consumed in county where grown.		Shipped out of county where grown.	
	Bushels.	*Bushels.*	*P. ct.*	*Bushels.*	*P. ct.*	*Bushels.*	*P. ct.*
Maine	1,008,000	302,400	30	997,920	99	10,080	1
New Hampshire	1,259,000	365,110	29	1,246,410	99	12,590	1
Vermont	1,839,000	662,040	36	1,820,610	99	18,390	1
Massachusetts	1,868,000	579,080	31	1,868,000	100	....	......
Rhode Island	402,000	136,680	34	389,940	97	12,060	3
Connecticut	2,014,000	664,620	33	2,014,000	100	....	......
New York	17,101,000	5,472,320	32	16,929,990	99	171,010	1
New Jersey	11,185,000	4,697,700	42	10,066,500	90	1,118,500	10
Pennsylvania	38,043,000	14,456,340	38	34,238,700	90	3,804,300	10
Delaware	4,128,000	1,940,160	47	3,096,000	75	1,032,000	25
Maryland	16,333,000	6,859,860	42	11,923,090	73	4,409,910	27

States and Territories.	Crop of 1890.	Stock on hand March 1, 1891.		Consumed in county where grown.		Shipped out of county where grown.	
	Bushels.	*Bushels.*	*P. ct.*	*Bushels.*	*P. ct.*	*Bushels.*	*P. ct.*
Virginia	36, 922, 000	17, 353, 340	47	33, 229, 800	90	3, 692, 200	10
North Carolina	36, 264, 000	17, 406, 720	48	34, 088, 160	94	2, 175, 840	6
South Carolina	16, 078, 000	7, 395, 880	46	15, 434, 880	96	643, 120	4
Georgia	31, 306, 000	14, 713, 820	47	30, 366, 820	97	939, 180	3
Florida	4, 570, 000	2, 056, 500	45	4, 478, 600	98	91, 400	2
Alabama	25, 390, 000	11, 679, 400	46	24, 374, 400	96	1, 015, 600	4
Mississippi	24, 396, 000	10, 978, 200	45	23, 908, 080	98	487, 920	2
Louisiana	16, 979, 000	7, 470, 760	44	16, 639, 420	98	339, 580	2
Texas	63, 802, 000	23, 606, 740	37	62, 525, 960	98	1, 276, 040	2
Arkansas	33, 443, 000	13, 377, 200	40	32, 774, 140	98	668, 860	2
Tennessee	67, 692, 000	31, 138, 320	46	62, 276, 640	92	5, 415, 360	8
West Virginia	13, 435, 000	4, 702, 250	35	12, 897, 600	96	537, 400	4
Kentucky	63, 645, 000	24, 185, 100	38	56, 007, 600	88	7, 637, 400	12
Ohio	65, 876, 000	19, 104, 040	29	58, 629, 640	89	7, 246, 360	11
Michigan	26, 580, 000	7, 176, 600	27	25, 516, 800	96	1, 063, 200	4
Indiana	89, 025, 000	24, 927, 000	28	76, 561, 500	86	12, 463, 500	14
Illinois	187, 446, 000	63, 731, 640	34	144, 333, 420	77	43, 112, 580	23
Wisconsin	33, 061, 000	10, 910, 130	33	31, 738, 560	96	1, 322, 440	4
Minnesota	21, 286, 000	6, 811, 520	32	20, 221, 700	95	1, 064, 300	5
Iowa	232, 439, 000	86, 002, 430	37	185, 951, 200	80	46, 487, 800	20
Missouri	175, 345, 000	63, 124, 200	36	152, 550, 150	87	22, 794, 850	13
Kansas	55, 269, 000	15, 475, 320	28	48, 084, 030	87	7, 184, 970	13
Nebraska	55, 310, 000	17, 699, 200	32	47, 013, 500	85	8, 296, 500	15
California	4, 396, 000	1, 186, 920	27	3, 824, 520	87	571, 480	13
Oregon	173, 000	25, 950	15	167, 810	97	5, 190	3
Colorado	767, 000	230, 100	30	751, 660	98	15, 340	2
The Dakotas	12, 030, 000	3, 127, 800	26	11, 548, 800	96	481, 200	4
New Mexico	1, 126, 000	247, 720	22	1, 092, 220	97	33, 780	3
Utah	739, 000	192, 140	26	702, 050	95	36, 950	5
Total	1, 489, 970, 000	542, 173, 250	36. 4	1, 302, 280, 820	87. 4	187, 689, 180	12. 6

This distribution, as shown by sections, indicates an increase in the proportion of the crop consumed, with a decrease in actual quantity, in every group of States, as follows:

Sections.	1890.				1891.			
	Retained for county consumption.		Distribution beyond county lines.		Retained for county consumption.		Distribution beyond county lines.	
	Bushels.	*P. ct.*	*Bushels.*	*P. ct.*	*Bushels.*	*P. ct.*	*Bushels.*	*P. ct.*
New England	8, 534, 660	99. 9	10, 340	. 1	8, 336, 880	99. 4	53, 120	. 6
Middle	68. 660, 400	89. 9	7, 736, 600	10. 1	64, 331, 190	91. 3	6, 125, 810	8. 7
Southern	395, 296, 180	92. 1	33, 839, 820	7. 9	352, 019, 990	94. 3	21, 155, 010	5. 7
Western	1, 235, 466, 460	78. 4	341, 121, 540	21. 6	859, 505, 700	84. 4	159, 211, 300	15. 6
Pacific	3, 948, 260	85. 4	672, 740	14. 6	3, 992, 330	87. 4	576, 670	12. 6
Nevada, Colorado, and Territories	16, 807, 370	95. 5	797, 630	4. 5	14, 094, 730	96. 1	567, 270	3. 9
Total	1, 728, 713, 330	81. 8	384, 178. 670	18. 2	1, 302, 280, 820	87. 4	187, 689, 180	12. 6

PROPORTION MERCHANTABLE.

The crop of 1890 was not quite up to the average in the proportion of sound corn, being surpassed by five of eight successive crops, a little better than that of 1885, and much better than that of 1883, which was severely injured by frost. The injury was mostly from excessive moisture on the Atlantic coast, and in the interior valleys from drought.

Years.	Merchantable.		Unmerchantable.	
	Bushels.	*P. ct.*	*Bushels.*	*P. ct.*
1883	935, 926, 541	60	615, 140, 354	40
1884	1, 593, 332, 101	89	202, 196, 331	11
1885	1, 583, 012, 860	78	353, 163, 140	22
1886	1, 438, 446, 830	86	226. 994, 170	14
1887	1, 222, 166, 360	84	233, 994, 640	16
1888	1, 637, 405, 930	82. 4	350, 384, 070	17. 6
1889	1, 810, 557, 850	85. 7	302, 334, 150	14. 3
1890	1, 183, 794, 720	79. 5	306, 175, 280	20. 5

Percentage of merchantable.

States and Territories.	Merchantable.				Unmerchantable.			
	Bushels.	Per cent.	Price per bushel.	Value.	Bushels.	Per cent.	Price per bushel.	Value.
Maine	806, 400	80	$0. 80	$645, 120	201, 600	20	$0. 40	$80, 640
New Hampshire	1, 032, 380	82	. 78	805, 256	226, 620	18	. 36	81, 583
Vermont	1, 452, 810	79	. 77	1, 118, 664	386, 190	21	. 37	142, 890
Massachusetts	1, 587, 800	85	. 76	1, 206, 728	280, 200	15	. 38	106, 476
Rhode Island	341, 700	85	. 77	263, 109	60, 300	15	. 39	23, 517
Connecticut	1, 611, 200	80	. 76	1, 224, 512	402, 800	20	. 38	153, 064
New York	12, 312, 720	72	. 68	8, 372, 650	4, 788, 280	28	. 35	1, 675, 898
New Jersey	9, 283, 550	83	. 70	6, 498, 485	1, 901, 450	17	. 36	684, 522
Pennsylvania	31, 195, 260	82	. 66	20, 588, 872	6, 847, 740	18	. 34	2, 328, 232
Delaware	3, 426, 240	83	. 60	2, 055, 744	701, 760	17	. 35	245, 616
Maryland	13, 393, 060	82	. 60	8, 035, 836	2, 939, 940	18	. 33	970, 180
Virginia	29, 906, 820	81	. 64	19, 140, 365	7, 015, 180	19	. 35	2, 455, 313
North Carolina	29, 011, 200	80	. 70	20, 307, 840	7, 252, 800	20	. 36	2, 611, 008
South Carolina	12, 701, 620	79	. 78	9. 907, 264	3, 376, 380	21	. 37	1, 249, 261
Georgia	24, 418, 680	78	. 79	19, 290, 757	6, 887, 320	22	. 35	2, 410, 562
Florida	3, 747, 400	82	. 80	2, 997, 920	822, 600	18	. 37	304, 362
Alabama	20, 312, 000	80	. 74	15, 030, 880	5, 078, 000	20	. 36	1, 828, 080
Mississippi	19, 028, 880	78	. 77	14, 652, 238	5, 367, 120	22	. 38	2, 039, 506
Louisiana	13, 583, 200	80	. 80	10, 866, 560	3, 395, 800	20	. 40	1, 358, 320
Texas	47, 851, 500	75	. 76	36, 367, 140	15, 950, 500	25	. 40	6, 380, 200
Arkansas	24. 078, 960	72	. 75	18, 059. 220	9, 364, 040	28	. 40	3, 745, 616
Tennessee	46, 030, 560	68	. 59	27, 158, 030	21, 661, 440	32	. 32	6, 931, 666
West Virginia	9, 941, 900	74	. 68	6, 760, 492	3, 493, 100	26	. 38	1, 327, 371
Kentucky	48, 370, 200	76	. 57	27, 571, 014	15, 274, 800	24	. 32	4, 887, 938
Ohio	48, 748, 240	74	. 58	28, 273, 979	17, 127, 760	26	. 32	5, 480, 886
Michigan	19, 137, 600	72	. 60	11, 482, 560	7, 442, 400	28	. 31	2, 307, 143
Indiana	69, 439. 500	78	. 55	38, 191, 725	19, 585, 500	22	. 30	5, 875, 654
Illinois	159. 329, 100	85	. 49	78, 071, 259	28, 116, 900	15	. 33	9, 278, 570
Wisconsin	25, 456, 970	77	. 49	12, 473, 915	7, 604, 030	23	. 29	2, 205, 167
Minnesota	16, 815, 940	79	. 47	7, 903, 492	4, 470, 060	21	. 33	1, 475, 120
Iowa	197, 573, 150	85	. 45	88, 907, 918	34, 865, 850	15	. 32	11, 157, 072
Missouri	140, 276, 000	80	. 47	65, 929, 720	35, 069, 000	20	. 29	10, 170, 010
Kansas	39, 240, 990	71	. 49	19, 228, 085	16, 028, 010	29	. 32	5, 128, 963
Nebraska	46, 460, 400	84	. 48	22, 300, 992	8, 849, 600	16	. 30	2, 654, 880
California	3, 956, 400	90	. 75	2, 967, 300	439, 600	10	. 40	175, 840
Oregon	145, 320	84	. 73	106, 084	27, 680	16	. 37	10, 242
Colorado	613, 600	80	. 77	472, 472	153, 400	20	. 32	49, 088
The Dakotas	9, 624. 000	80	. 47	4, 523, 280	2, 406, 000	20	. 31	745, 860
New Mexico	923, 320	82	. 75	692, 490	202, 680	18	. 38	77, 018
Utah	628, 150	85	. 70	439, 705	110, 850	15	. 38	42, 123
Total	1. 183, 794, 720	79. 5	. 558	660, 889, 672	306, 175, 280	20. 5	. 329	100, 855, 460

PRICES.

The following table shows the course of farm prices for fifteen years, and the wide local variations caused by varying supply and distance from markets:

States.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.
	Cts.	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*
Kentucky	32	40	37	28	70	52	42	43	35	34	53	34	34	49
Ohio	40	33	39	41	61	62	47	41	32	35	48	35	31	51
Michigan	39	38	45	46	63	59	52	40	34	38	48	42	37	55
Indiana	34	27	34	40	60	48	41	34	29	32	45	31	27	47
Illinois	29	25	31	36	58	47	40	31	28	31	41	29	24	43
Wisconsin	33	29	39	39	54	53	48	34	34	37	42	36	29	45
Minnesota	38	29	27	36	53	45	43	33	32	34	37	32	27	42
Iowa	25	16	24	26	44	38	32	23	24	30	35	24	19	41
Missouri	27	26	25	36	65	39	35	26	25	31	37	30	23	44
Kansas	21	19	27	29	58	37	26	22	24	27	37	26	18	51
Nebraska	18	16	21	25	39	33	24	18	19	20	30	22	17	48
The Dakotas	....	....	....	....	....	51	45	30	28	37	35	33	33	50
United States	35. 8	31. 8	37. 5	39. 6	63. 6	48. 5	42. 4	35. 7	32. 8	36. 6	44. 4	34. 1	28. 3	50. 6

The export prices, or those of the seaports for corn exported, will show the difference between values on the farms and on the Atlantic

coast, which is made up of transportation charges, commissions, and dealers' profits.

Years ending June 30—	Price.	Years ending June 30—	Price.
	Cents.		*Cents.*
1878	56.2	1885	54.0
1879	47.1	1886	49.8
1880	54.3	1887	48.0
1881	55.2	1888	55.0
1882	66.8	1889	47.4
1883	68.4	1890	41.8
1884	61.1		

WHEAT.

The wheat from the crop of 1890 remaining in the hands of growers March 1, 1891, is less by 15 per cent than the average of the preceding ten years and less by 33 per cent than the reserve following the large crop of 1884. It has been lower only in two years since 1880, and even then by a small margin. The reserves have been heavily drawn upon, and are necessarily very low. The fact of a difference of 71,000,000 bushels in the March invisible stocks, as reported annually to this Department and verified remarkably in subsequent distribution, should teach a wholesome lesson of the great capacity of farmers' granaries in the absorption of a surplus of production. The truth unquestionably is that there is a strong tendency in the public mind to underestimate the reserves in the hands of farmers. Dealers in grain, bona fide or by the fiction of futures, who see daily the visible stocks paraded, which are at any time a very small proportion of the annual production, come to regard with indifference and unbelief the existence of stocks in the hands of growers. They live by sight entirely and have little faith in anything they do not see, and therefore gravely miscalculate the possibilities of reserves that remain in the granaries of farmers. The surplus of two or three years, held in remote regions not easy of access, in Russia, and India, and elsewhere, have been collected through improved commercial facilities and poured into the centers of trade, to the surprise of both consumers and producers, to the equalization of prices, and the maintaining of relatively low rates throughout the world.

The following statement gives the March reserves of each crop since that of 1879:

Years.	Crops of previous years.	In farmers' hands March 1.		Years.	Crops of previous years.	In farmers' hands March 1.	
	Bushels.[3]	*Bushels.*	*P. ct.*		*Bushels.*	*Bushels.*	*P. ct.*
1891	399,262,000	112,000,000	28.2	1885	512,765,000	169,000,000	33
1890	490,560,000	156,000,000	31.9	1884	421,086,160	119,000,000	28.3
1889	415,868,000	112,000,000	26.9	1883	504,185,470	143,000,000	28.4
1888	456,329,000	132,000,000	28.9	1882	383,280,090	98,000,000	25.6
1887	457,218,000	122,000,000	26.7	1881	498,549,868	145,000,000	29.1
1886	357,112,000	107,000,000	30.1				

The following statement of supply and distribution is made on the same basis of rate of consumption per head that has been used for a dozen years, accounting with remarkable closeness for the estimate of production, which is always made at least six months in advance of any

possible verification by the fact of the commercial movement of the crop year:

	Distribution.	Supply.
	Bushels.	*Bushels.*
Visible supply March 1, 1890		29,000,000
In farmers' hands, 1890		156,000,000
Crop of 1890 (round numbers)		399,000,000
Consumption, twelve months	299,000,000	
Seed, spring and fall	53,000,000	
Exported, March 1, 1890, to March 1, 1891	98,000,000	
Visible supply March 1, 1891	23,000,000	
In farmers' hands March 1, 1891	112,000,000	
Total	585,000,000	584,000,000

These figures of distribution and supply vary only by a million bushels. The discrepancy might be 10,000,000 without necessarily impairing the reliability of the data, the largest element being consumption, as there might easily be such a difference, which would be less than two weeks' consumption in the stocks of flour which are in the hands of wholesale and retail dealers and in hotels and private families —the variable stocks on the way from mill to mouth.

As to the item of 112,000,000, the reserve of the farms, which fits so well the gap in the record of distribution of last year's supply, it is the direct result of a calculation of the percentages reported by our correspondents, which come to us in duplicate, from two sets of correspondents, with some slight discrepancies, of course, which are harmonized, each case by itself, with no means of knowing what the aggregate will show until the work is done. The result this year, as in former years, has been so consistent with the other facts of supply and distribution as to be a surprise to those engaged in the consolidation, and to furnish irrefutable evidence of the substantial accuracy of the result. The figures of the balance sheet show such agreement that some innocents of the commercial boards have in great simplicity assumed that the reserves were obtained by figuring up the other items of distribution and deducting their sum from the aggregate of supply. This would be a very easy method, quite in accord with the superficial requirements of amateur crop reporting.

To show how estimated production has agreed with distribution in the past, counting actual exports, seed, and consumption on the basis of 4⅝ bushels per capita, a rate fixed after thorough investigation twelve years ago, the following table is given:

Years.	Production.	For food.	For seed.	Exportation.	Total distributed.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
1880	498,549,868	242,086,655	56,563,530	186,321,514	484,971,699
1881	383,280,090	235,249,812	55,215,573	121,892,389	412,357,774
1882	504,185,470	255,500,000	52,770,312	147,811,316	456,081,628
1883	421,086,160	259,500,000	54,683,389	111,534,182	425,717,571
1884	512,765,000	265,000,000	55,266,239	132,570,367	452,836,606
1885	357,112,000	271,000,000	51,474,906	94,565,794	417,040,700
1886	457,218,000	277,000,000	51,528,658	153,804,970	482,333,628
1887	456,329,000	283,000,000	53,009,982	119,625,344	455,635,326
1888	415,868,000	288,000,000	54,012,702	88,600,743	430,613,445
1889	490,560,000	294,000,000	53,973,000	109,430,467	457,403,467
Total	4,496,953,588	2,670,336,467	538,498,291	1,266,157,086	4,474,991,844
Average	449,695,359	267,033,647	53,849,829	126,615,709	447,499,184

The estimated production of ten years averages 449,695,359 bushels per annum; the distribution, including consumption, seed, and exports,

averages 447,499,184 bushels, leaving unaccounted for during the entire period of ten years an average of only 2,196,175 bushels per annum. This difference is scarcely enough to cover the loss by fire and sinking in the lakes. The consumption is on the basis of 4⅔ bushels per head. In most of the Northern States it is about 5 bushels per head, but in some of the cotton States, with a large colored population, the consumption is from 3 to 4 bushels.

PRICES.

Average farm price of wheat for the years 1877–'90.

States.	1877.	1878.	1879.	1880.	1831.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.
Kentucky	$0.99	$0.76	$1.08	$0.93	$1.[illegible]1	$0.90	$0.95	$0.74	$0.95	$0.72	$0.73	$0.96	$0.72	$0.92
Ohio	1.24	.86	1.20	1.02	1.29	.95	.99	.75	.91	.74	.75	.97	.76	.91
Michigan	1.22	.85	1.17	.97	1.25	.90	.96	.74	.84	.73	.74	.98	.74	.90
Indiana	1.13	.81	1.17	.99	1.27	.90	.95	.67	.86	.70	.72	.94	.71	.88
Illinois	1.04	.75	1.07	.95	1.22	.86	.92	.63	.81	.69	.70	.93	.70	.87
Wisconsin	.93	.67	1.04	1.00	1.19	.90	.88	.60	.76	.68	.64	.96	.70	.83
Minnesota	.91	.51	.94	.87	1.06	.82	.80	.50	.70	.61	.59	.92	.71	.81
Iowa	.87	.50	.92	.82	1.06	.70	.80	.55	.67	.60	.61	.85	.63	.80
Missouri	1.00	.67	1.01	.89	1.19	.85	.88	.62	.77	.63	.62	.88	.64	.83
Kansas	.82	.59	.89	.70	1.05	.67	.78	.45	.65	.58	.61	.88	.55	.77
Nebraska	.83	.49	.84	.73	.97	.67	.70	.42	.57	.47	.53	.83	.52	.76
The Dakotas	......	......	......	......	......	.80	.72	.46	.63	.52	.52	.91	.60	.70
United States	1.082	.777	1.108	.951	1.192	.882	.911	.645	.771	.687	.681	.926	.698	.838

Average export price of wheat.

Years.	Average price.	Years.	Average price.
1874–'75	$1.12	1882–'83	$1.13
1875–'76	1.24	1883–'84	1.07
1876–'77	1.17	1884–'85	.862
1877–'78	1.34	1885–'86	.870
1878–'79	1.07	1886–'87	.890
1879–'80	1.24	1887–'88	.853
1880–'81	1.11	1888–'89	.897
1881–'82	1.19	1889–'90	.832

WEIGHT PER BUSHEL.

The weight per bushel is determined by an investigation accomplished through the aid of our correspondents, the returns of State agents, the statements of actual weights of grain purchased by millers, elevator men, and all available sources of information, including the records of inspections in wheat markets. The weight of the crops of eight years past is thus stated:

Years.	Weight per bushel.	Measured bushels.	Weight in pounds.	Bushels of 60 pounds.
	Pounds.			
1883	56.9	420,154,500	23,906,128,850	398,435,481
1884	58.3	512,763,900	29,912,751,800	498,545,863
1885	57.0	357,112,000	20,369,787,000	339,496,449
1886	58.4	457,218,000	26,686,632,000	444,777,202
1887	58.5	456,329,000	26,702,852,300	445,047,538
1888	56.5	415,868,000	23,485,066,800	391,417,782
1889	57.7	490,560,000	28,287,039,600	471,460,663
1890	57.2	399,262,000	22,854,954,200	380,915,903

PERMANENCY OF AGRICULTURAL PRODUCTION.

The increase of our population, and the necessary decline in proportion of agricultural producers to consumers, tends to enlarge the proportion of products consumed at home, and must continue to do so, and consequently to increase the prices of products and presumably the profits of agriculture. This tendency, which is indisputable and inevitable, is a source of consolation in temporary depression and of hope for a cheerful future. While taking this cheerful outlook ahead, aided by the logic of current statistics, there is no need of going to the other extreme, and prophesying exhaustion of fertility, inability to support population, and general decadence and paralysis of agricultural production. The crude practice of two-thirds of our farmers should be reformed; the low yields which are a disgrace to our agriculture should be raised by advanced methods and the infusion of science and sense in practice. To claim that this low rate of production must continue is to encourage apathy and to repress enterprise. To say that the millions of acres of fertile "wastes" in the South and the mountain regions shall be forever useless, and that the half-occupied and carelessly cultivated farms of the country shall remain in a condition in which it is scarcely possible to produce enough to pay the cost of the shiftless labor expended on them, is to be unworthy of the position of a rural teacher in this age of discovery and progress. The sloth should not be the emblem of the agriculture of to-day; rather the busy bee, the alert and early cock of the morning walk, or the sure-footed maker of the 2:10 pace.

As a whole, there has been no overproduction in this country; as to cotton, wheat, and some other products, under the baneful influence of the single-crop idea, there has been, and it has been the main factor of depression of prices. Cotton to-day is suffering from a depression in value from no other source whatever. At the same time we demand and use products worth two or three hundred million dollars which should be produced here. This diversity would boom agriculture and turn depression into high prosperity.

We should seek foreign markets for any possible surplus; and still we should disabuse ourselves of the insane idea that foreign countries can sit idle by their fertile fields and procure their food from the antipodes. The cry of starvation comes to us from an agricultural district in Europe for the first time in a generation, and 50,000,000 bushels of grain have been exported from the same country this season, while its Government claims that there is enough left to last until the next crop. Whatever starvation may come, it will be seen that no importation of breadstuffs, or little, if any, will follow. Starving people can not buy grain, and most of the countries of Europe must continue to produce it or starve.

Many of our agricultural writers fail to analyze properly the available statistics of the day, and are led into false views by the failure, or make unreasonable or erroneous conclusions from incomplete or inaccurate data. Statistical data are edge tools in the hands of the inexpert. There are statistical fallacies promulgated, in many directions and from many sources, which should be corrected, in the interest of the public good and the profit of agriculture. A few of these will be considered. One of these is ignorance as to conditions of agricultural production in Europe.

EUROPE NEARLY SELF-SUPPORTING.

Europe has four times as many people as the United States, and very few of the countries represented by this eastern continent fail to produce nearly or quite enough for their own subsistence. All eastern Europe has an agricultural surplus; and Italy's exports equal her imports. Even the Netherlands, with only 2½ acres to each inhabitant, require only a few million of dollars' worth of agricultural imports in excess of agricultural exports. France requires from foreign sources only about 7 per cent of her consumption for a population nine times as dense as ours. Insular and factory-studded Great Britain feeds one-half of her people from her soil, through a labor of one-eighth of her population, and her game preserves and pleasure grounds are enough to feed the other half if utilized for agricultural production.

It would seem to be an absurdity to claim a necessity of four times as much area to feed one person in this country as it requires in Europe, with whatever allowance may be necessary for more liberal dietary. The contention becomes the more unreasonable in view of the fact that half of the area of Europe could easily double its production under more general and higher cultivation.

OUR RESOURCES NOT EXHAUSTED.

Is our public land all taken up? A considerable part of the arid area is not even surveyed. With the utilization of all the possibilities of irrigation, tens of millions of acres will be opened for cultivation. In lands, as in forest products, the specialist has for years prophesied utter and almost immediate exhaustion, yet lands are still annually patented by millions of acres, and forest products are growing while the reverberations of the ax are dying away. It is not denied that the public-land area is decreasing rapidly or that the heavy timber of the forest is melting gradually away, but not so rapidly in either case as sensational writers would intimate.

Some evidently assume that all available farming lands are already occupied. By no means, even in the original States. Little more than a third of Maine is in farms, and colonization of the most fertile unoccupied area of that State is in progress. From a sixth to a fifth of the land in the South is utilized for production, and millions of acres of its richest and deepest soils are as yet untouched. One-tenth of the area of Florida is fifteen times the entire breadth of the sugar cane in the United States in 1880, situated several degrees of latitude south of existing plantations, requiring only a system of drainage to become the best cane lands of the United States.

The land actually in farms is only partially utilized in cultivation in every State east of the Mississippi, and the productiveness of cultivated lands is far below its possibilities. As a rule, outside of the prairies, the poorest lands were first in cultivation, in violence to the dictum established by town-residing economists of the old school. Our richest lands are the most heavily wooded, the most difficult and expensive to clear, and swamp lands requiring combination and capital to drain. There are lands now commanding an annual rental higher than the present average value of our farm lands, west as well as east of the Alleghenies, which were less than a generation ago too nearly valueless to find a purchaser willing to pay nominal taxes on them. Millions of acres of the richest and intrinsically most valuable lands of the Atlantic coast, awaiting perfectly feasible drainage, are yet to be brought

into cultivation, while the unoccupied lands of the lower Mississippi are scarcely less extensive. In fact, the entire idea of nearing exhaustion of productive lands is based on the assumption of necessary continuance of primitive methods in agriculture, the cheapest and most superficial culture, and stagnation of all rural progress.

THE SURPLUS NOT UNLIMITED.

While one class is prophesying decline in relative supply as population increases, another goes to the opposite extreme, and assumes the probability of overproduction, the ability to "feed the nations," and practically unlimited production. Such views often originate in lack of information and excess either of patriotic or partisan zeal. While there has been in productive years positive overproduction of certain crops, from adhesion to the agricultural traditions of the fathers, preventing diversification necessary to supply old wants not met under primitive agricultural conditions and the new wants of advancing civilization, there is now underproduction or nonproduction which has a very repressive effect on agricultural activities, resulting in rural stagnation and depression.

The March, 1891, report of the Department of Agriculture showed how small a proportion of the agricultural consumption of the European nations is represented by the net imports of each, several of them having a surplus, others a very small deficit, and only Great Britain and Belgium any large dependence on foreign agriculture. Not a dollar's worth of our usual surplus will be taken except to supply an imperative demand. Any overburdening of the market instantly reduces the price, whether in cotton or tobacco, wheat or corn. In the case of meats, there is opportunity for increase of sales, of opening of new markets, as the exportation of fresh meats was initiated less than fifteen years ago and is still susceptible of great extension. Foreigners do not buy of us for our advantage, but always for their own; from necessity rather than preference; for cash, and not for barter; some nations selling us five to ten times as much as they buy of us; others buying from us much more than they sell to us, simply because they need the goods and must have them. While no nation has such a surplus as ours, and none can expect to have in the near future, it should be understood that nine-tenths of our aggregate production is consumed at home, and that as population increases the tendency will be toward decrease of the *proportion* exported, even though the *quantity* should increase.

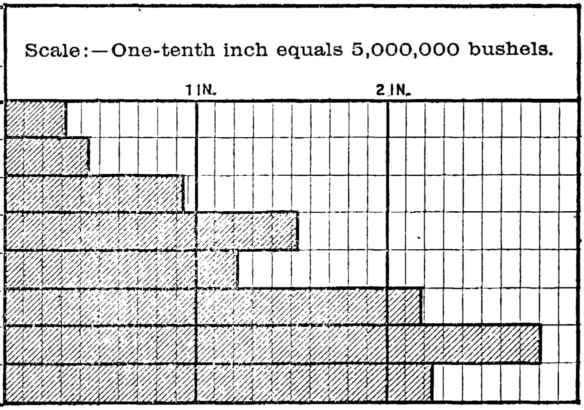
It would be possible, under the spur of necessity or of large profit, as when the wheat exports of the war period were doubled while the able-bodied yeomen of the West were far away upon tented fields, to increase the surplus. To find purchasers at a profit for such a rate of increase would now be a more difficult problem. Limitation of demand would lead to a reduction of price and destruction of profit.

Climatic influences cause unavoidable fluctuations, which are evened up in a series of years or in a group of countries in a single year. The areas of winter crops may be decimated and those of spring planting proportionately increased. If extraordinary demand arises it is promptly met, and will be in the future as it has been in the past, and land and labor will be abundant to meet it, even if the result should break the record of uniformity in rural progress.

THE WHEAT SURPLUS NOT IMMEDIATELY EXHAUSTIBLE.

False deductions from agricultural statistics come from partial knowledge of controlling conditions. A very common error of statistical writers, for example, is the assumption of a future rate of decline of wheat exports based upon the reduction since 1880. The status of these exports is shown in the following illustration in periods of five years:

Period ended	Average Annual Export. Bushels.
1855.	16,433,909.
1860.	23,539,983.
1865.	47,456,015.
1870.	77,816,458.
1875.	61,601,559.
1880.	109,262,964.
1885.	140,025,954.
1890.	113,205,463.



Were the present fiscal year's exports complete, it would show, even if coupled with the small shipments of 1890–'91, a positive advance upon the average of the remarkable shipments of the quinquennial of 1885. It is probable, and nearly certain, that the exports of the present year will considerably exceed those of the largest previous annual exportation. The large exportation of the period, 1881–'85 was altogether exceptional,the accident of fluctuating production; for in three years in which exports reached their highest point, no less than 514,000,000 bushels went abroad, about as much as in the seven preceding years, and the cause was a partial failure of crops in western Europe. The Statistician at that time warned wheat-growers that this abnormal demand would not continue; that good crops in western Europe and reduction of demand would follow. The decline began at once; acreage in this country was reduced, and wheat-growers grumbled at unremunerative prices. Now, going to the other extreme, since the amount has fallen from 186,000,000 bushels in 1880–'81 to 89,000,000 bushels in 1888–'89, agricultural writers are prophesying speedy exhaustion of surplus and early demand for foreign wheat. This deduction is quite as unreasonable as the other. It is a question of price and profit, and not of land and labor.

NOR IS WHEAT-GROWING DECLINING IN EUROPE.

Another fallacy relative to cereal production is that it is declining perceptibly in Europe. There are annual fluctuations, but no material change. The following statement of the last five years includes the final official estimate of each European country which makes annual estimates, except as to 1890, in which case there are some preliminary estimates:

Wheat crop of Europe, by countries, from 1886 to 1890.

Countries.	1886.	1887.	1888.	1889.	1890.
Austria-Hungary:	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
Austria	44, 644, 090	52, 351, 733	51, 843, 452	38, 376, 705	44, 059, 942
Hungary	102, 846, 419	145, 906, 514	135, 859, 786	92, 725, 057	154, 700, 500
Belgium	17, 099, 782	19, 894, 859	14, 876, 130	19, 573, 075	19, 573, 075
Denmark	5, 201, 416	6, 021, 412	3, 805, 301	4, 977, 661	5, 776, 512
France	304, 427, 095	319, 094, 204	280, 176, 816	307, 357, 350	309, 437, 805
Germany	97, 973 269	104, 013, 175	92, 991, 571	87, 170, 354	104, 020, 780
Great Britain and Ireland	65, 285, 353	78, 567, 593	76, 760, 671	78, 190, 962	78, 389, 210
Greece	4, 937, 250	5, 000, 000	4, 823, 750	5, 000, 000	12, 378, 240
Italy	113, 422, 020	119, 509, 868	104, 247, 503	102, 992, 122	131, 433, 426
Netherlands	5, 238, 025	6, 889, 450	4, 256, 250	5, 675, 000	6, 189, 120
Portugal	8, 228, 750	6, 000, 000	7, 093, 750	8, 512, 500	8, 252, 160
Roumania	23, 629, 063	61, 000, 000	51, 075, 000	44, 784, 853	63, 954, 240
Russia in Europe (exclusive of Poland and Finland)	163, 455, 273	278, 697, 917	295, 711, 493	178, 483, 452	213, 031, 826
Servia	4, 525, 813	5, 000, 000	9, 000, 000	5, 000, 000	10, 315, 200
Spain	85, 958, 973	95, 000, 000	75, 866, 831	75, 622 213	75, 530, 734
Sweden and Norway	4, 081, 115	4, 600, 174	4, 128, 279	3, 991, 795	4, 368, 651
Switzerland	1, 645, 750	2, 000, 000	1, 702, 500	2, 270, 000	2, 475, 648
Turkey	41, 143, 750	42, 000, 000	42, 562, 500	39, 725, 000	37, 134, 720
Total	1, 092, 773, 206	1, 351, 549, 399	1, 256, 781, 583	1, 100, 428, 099	1, 281, 021, 789

The average of these five years is 1,219,000,000 bushels, while that of the five preceding years gives no larger figures; and the investigation in 1873 by the European Statistical Commission produced a similar result. It should be remembered, however, that Poland, Finland, European Turkey, Bulgaria, Roumelia, and certain principalities having an area of more than 320,000 square miles are not included. There is reason to believe that the average production of wheat of these countries exceeds 25,000,000 bushels. The real average of wheat production in the last five years may be fairly stated, in round numbers, at 1,250,000,000 bushels.

THE INDIAN SCARE.

A commercial fallacy, based on current statistics, was generally prevalent a few years ago relative to India wheat. The building of a few railroad lines brought to the seacoast a surplus that had always existed in productive seasons, which was preserved in pits to tide over the possible requirements of seasons of scarcity. This opportunity for exportation, stimulated by the difference in Liverpool value of silver and gold, enlarged the normal area of about 26,000,000 acres in 1878 to 28,000,000 in 1884-'85, since which date there has been a general decline to lower figures than those accepted as the acreage before there was any exportation, those of 1889-'90 being less than 25,000,000.

In the report of the Statistician for November, 1887, the public was cautioned not to receive certain views of commercial writers which were extravagant and sensational, making India a veritable bugbear in the American wheat market. The idea, so improperly promulgated, of rapid increase of acreage, improvement of methods of cultivation, introduction of improved implements, threatening a monopoly of the supply of the European deficiency, was duly combatted. It was deprecated and positively denied in these pages. The palpable fact was insisted upon that such changes were improbable; that there was a dense population to feed, comparative scarcity of food products, and tenacious habits and prejudices of centuries, making sudden changes impossible; that "the natives still work for a few cents a day, plow with a stick, thrash in the primitive fashion, and market dirt and seeds of weeds with the grain," and that "there is scarcely a people on the face of the earth less likely

to change their industrial status suddenly." A prediction of declining area and exportation has been verified from official records, which show a decrease of more than 3,000,000 acres. The largest exportation was 41,558,765 bushels of domestic product in 1886-'87, and that of 1889-'90 only 25,764,123 bushels. The record is found in detail, by countries to which exported, in the March report (page 84). If recent official indications of the Indian Government are conclusive and final, very little wheat may be expected to go out of India from the harvest just completed.

CONCLUSIONS.

This country has not reached the limit of agricultural production. It has not even approached it. One-third of its area is either too dry or too wet for present cultivation, awaiting irrigation or drainage. Of the other two-thirds there is much not included in farms; its farm area is not all utilized, and the cultivated area may become far more productive.

Farm labor is not sufficiently effective; its distribution could be more harmonious and profitable. Prices of cereals have sometimes been reduced by oversupply. Cotton, with a product of 22,000,000 bales in three years, a quantity greater than the production of six years prior to 1860, begins to decline in price. At the same time there is a failure to produce the sugar required, though there is cane land sufficient for an ample supply and beet-sugar lands *ad libitum*, without mentioning the possibilities of sorghum. There might be tens of millions of dollars annually coined from various fibers, large extension of fruit-growing, and introduction of many economic plants to be made the basis of new industries. The material now produced for food consumption might be put in more attractive form for market and a large contribution levied upon the gastronomic and æsthetic tastes of consumers.

It is not true that the wheat of the world is declining. It is not difficult to prove the existence of 2,300,000,000 bushels as an average, and there is no prospect of decrease. Annual fluctuations, from climatic causes, will produce variation in price, which the distribution of harvests of different climates through the year and increase of international transportation facilities will help to equalize. The United States will continue to produce a surplus for export, until the wheat culture of the plains shall have given place to more varied and profitable culture, and increasing numbers of nonagricultural population shall require for bread the entire crop.

It is proper to say that the tendency is towards a better distribution of crops and to higher prices and better profits. The proportion of agricultural labor will decrease, nonagricultural will increase, agricultural production will be more varied, rural intelligence and skill will advance, and the farmer be in better position to demand and secure an equitable share in the net proceeds of national industries.

OFFICIAL RETURNS OF RUSSIAN CEREALS.

GRADUAL DEVELOPMENT OF CROP STATISTICS.

The present statistical system of crop reports of Russia was put into practice first in 1883. An official statement of the growth of this system states that in 1865 the only information concerning the breadth and product of cereals was the result of a tentative and imperfect collection of statistics of winter and spring grains and potatoes by the

commissioners of the national supply of provisions, which was worked up by the central statistical committee and intended to be issued as a first chronicle (vremennik). It attempted to give for a five years' period the product of wheat and rye together (winter grain), and spring wheat, oats, millet, etc., as spring grains, placing together cereals used as food for man with those used for feed for farm animals mainly. This is referred to as "a gross fault, which has made the statistical data about the crops almost useless for any consideration or deductions." These appeared, under careful elaboration and critical examination, so imperfect that the statistical committee did not decide to publish them. According to these data some of the most fertile provinces of Russia, as Pedolsk and others, were not in a condition to support their own population, while considerable exports of grain appeared in commercial records. The only practical result of their effort was a further investigation by the committee of improved methods of collecting statistics from 1866 to 1868, revealing the entire impracticability of the methods before employed.

Owing to the ignorance of a majority of the producers, the sending of blanks to be filled up was not practicable, and there was not time enough for the police functionaries to find the individual producers and ascertain the facts and write them down. The committee came to the conclusion (previously expressed by the director, Mr. P. P. Semenoff) that the only available means of obtaining an idea of the crops of each year would be through the collection of facts concerning a certain number of representative farms and the fixing of an average rate of production, which should afterwards be applied to the aggregate of units of area, "desiatines," a desiatine being equivalent to 2.6997 acres of our measure. Another difficulty appeared: there was a complete lack of information regarding land-tax statistics of breadth of land under separate cultivation. An imperial commission to perfect such registration was found to be an essential preliminary, which could not, however, be put into immediate operation.

Thus the efforts of the central statistical committee were balked until 1870, when a further attempt was made to ascertain the area and product of crops, and in 1875 a publication was made of such statistics of 1870 and 1872. In the preface of this "chronicle" the director expresses again, and at this time still more emphatically, his opinion that success could not be realized until an official registration of the distribution of lands had been made. Then followed a general statistical investigation of the condition of land-tax property in Russia, which was authorized in 1876 by the minister of the interior, and in 1877 was published the first general inventory of such property, with a determination of the area of arable lands. At the conclusion of this elaboration it was proposed, by more complete investigation, to gather exact information relative to the arable lands under each separate crop; but this feature was not included in the inquiry of 1877, for fear of retarding the progress of the investigation by increasing the number of questions.

The increasing interest in the subject induced the minister of the interior to take further steps toward a more speedy gathering of information regarding seeding and harvest, and a special temporary commission was formed in 1880. At this point the official history of progress says:

Judging from the records which had been brought to the commission by the president of the statistical council, the commission was fully persuaded of what the central statistical commission had all the time endeavored to show since 1866, namely, the unsatisfactory results of existing methods of gathering information about sowing

and crops and the utter impossibility of collecting such information by questioning each producer of breadstuffs. A more comprehensive scheme was elaborated, with a broader basis of inquiry, and blanks were sent in the latter part of 1880, through the provincial statistical committees, twelve in each district, six to proprietors and six to peasants. The distribution had to be completed not later than the 1st of September of each year, filled and returned to the district authorities, and delivered to the provincial committee by the 20th of September, to be sent to the central statistical committee by the 1st of October. These were collected by January 5, 1881; there were 60,000 sheets, which were revised and tabulated by the 15th. The effort was deemed successful, but the commission decided not to publish the results, first, for want of available means for printing, and, second, because only a part of the data showing the distribution of crop areas was as yet available. This was not obtained till 1883.

Other official agencies had also been experimenting on the problem of crop determination. The department of agriculture and rural economy had for years worked for its solution, and had published statistical maps and other works relating to the rural economy of Russia, including the production of breadstuffs in Russia for the five years' period from 1870 to 1874, published in 1880. In this work the "deficiencies and inaccuracies of fundamental data" were acknowledged and deplored. This department, "fully recognizing the importance of establishment of economic statistics upon more solid principles," decided "to apply the new method of gathering economic statistical information which serves as the basis of rural economic statistics in the United States of North America, and which has been fully justified in practice, as is evidenced by the detailed monthly and yearly reports of the Washington Department of Agriculture, which seasonably brings to the notice of the country the data which are indispensable to the Government and to individuals interested in the production, consumption, distribution, and exchange of products of rural economy." The statement explains this method and shows by what agencies it should be applied in Russian practice. Returns were to be made at three dates: For the spring period, June 1; for the summer term, August 15; for the autumnal period, October 1. The effort met the sympathy of the farmers. The number of correspondents ran from 800 in 1881 to 2,200 in 1883. The condition of the growing crops was reported in the earlier returns, and in the third the local estimates of the rate of production per desiatine. These returns also include data relating to the distribution, exchange, and utilization of farm products, thus further following the methods in use in the statistical work of this department.

Another branch of the public service, the statistical division of the ministry of public works, makes investigation concerning the distribution of grain, exportation, prices, etc.

The Emperor in 1882 authorized the establishment of a statistical conference to utilize and harmonize the various sources of statistical information in relation to crops and supply of provisions in the Empire. The presidency of the conference was given to the director of the department of agriculture and rural economy and members were appointed from various departments and the ministries of the interior, imperial domains, roads, and communications. This conference directed the forwarding of returns of crop conditions on the 1st of June, July, and August, with two later returns of results. Some delay occurred in obtaining an appropriation to continue the work, which was granted in April, 1883. The schedules were prepared by the central statistical committee and secretary of the statistical division of the department of agriculture, and approved by the conference. The elaboration of the data obtained was not finished until January, 1884, and the printing was not commenced until the 18th day of December,

despite the fact that seventy-eight persons were specially employed to take part in the work.

This was declared to be the first experiment for the elaboration of this kind of data, with concurrent participation of several institutions, as it was the first authentic and approximately reliable report of the seeding and product of Russian cereals. It was acknowledged officially not to be free from defects, and coöperation for improvement was especially called for.

The difficulties encountered in this twenty years of strenuous and continuous effort to devise a practicable method of obtaining reliable crop statistics under existing social and economic conditions, and to test them by experiments until reasonable results were obtained, no one can appreciate who has not had experience in similar work. The labors by which the initiation of this system were accomplished, patient and untiring as they were, are worthy of all praise, and should lead to higher results and greater accuracy.

This synopsis of an official history of the evolution of Russian crop reporting shows how unreliable is the guesswork, assumption, and deduction from partial data of the earlier statistics of production. For purposes of comparison, as well as most other purposes, they are evidently discredited and discarded by Russian statisticians, who date the birth of a reasonable method and creditable results from the year 1883.

There is still a failure to show comparative area from year to year, which baffles effort to indicate the annual changes in breadth of crop and defies exactness in indicating crop progress.

OFFICIAL RECORD OF RUSSIAN CEREALS.

While official reports do not show annual estimates of area, it is unsafe to assume, as many have done, that there is no increase, and the idea that there has been a decline is still more untenable. With prices doubling since the initiation of the export trade, and exports quadrupling, it would be little less than absurd to suppose that such an influence would be powerless to affect Russian areas in cultivation. But it is not necessary to depend upon assumption, however reasonable, for belief in increase of cereal areas, as the report of 1891, just received, says of the crop failure of the past year:

> And if the increased area under cultivation be considered, the shortage of the present year will be found even more considerable than that of 1880.

This report gives specific information concerning the drought of 1891 and its results, with maps illustrating its distribution and local intensity. It included much of the southern portion of Russia, especially the "black earth belt" governments or provinces, embracing about two thirds of this fertile area and many localities beyond its limits. Statistics of meteorology published by the Imperial Geographical Society show that during June, July, and August, and in July particularly, the precipitation was very much below the normal. Drought reigned supreme over most of the black earth belt, with few and insignificant local exceptions. If some localities had some rainfall during June and July, they had none in August and September, and *vice versa*. The drought caused not only ponds and wells to dry and fields of grain to burn up, but in many localities the foliage on the trees became sere and yellow, and the landscape presented the aspect of an extremely hot autumn, instead of summer.

The regions where the crops of all kinds are the shortest are the

following: The southern portions of the government of Saratoff and Samara, the governments of Astrakhan and Orenburg, the southeastern corner of Perm, the territory of Uralsk, some localities in the territory of Akmolinsk, and the government of Tobolsk; also the eastern portion of the governments of Koursk, Orel, Toula, Voronege, Riazan, Tamboff, Penza, and Kazan, the southern half of the government of Nijni Novgorod, the northern of Simbirsk, and some districts of the government of Viatka.

The following is a table of the principal grain crops of the fifty governments (or provinces) of European Russia for the last eleven years, according to the information of the central statistical committee on the crops from 1883 to 1890, inclusive; the reports of the governors from 1880 to 1882, with the crop report for 1891, based on a preliminary calculation made by the bureau of agriculture and rural industry:

Years.	Rye.		Wheat.		Oats.		All cereals.	
	Chetverts.	Bushels.	Chetverts.	Bushels.	Chetverts.	Bushels.	Chetverts.	Bushels.
1880.....	87, 462, 470	520, 926, 471	27, 546, 647	164, 067, 830	85, 034, 765	506, 467, 060	251, 573, 603	1, 498, 372, 379
1881.....	105, 923, 250	630, 878, 877	44, 515, 370	265, 133, 544	101, 980, 737	607, 397, 270	311, 230, 282	1, 853, 687, 560
1882.....	105, 159, 522	626, 330, 113	40, 267, 339	239, 832, 271	93, 613, 280	557, 560, 696	290, 986, 753	1, 733, 117, 101
1883.....	89, 947, 092	535, 724, 880	36, 764, 302	218, 968, 183	93, 588, 004	557, 410, 152	272, 305, 438	1, 621, 851, 189
1884.....	115, 244, 045	686, 393, 532	44, 811, 454	266, 897, 020	84, 116, 668	500, 998, 875	293, 253, 784	1, 746, 619, 533
1885.....	117, 817, 900	701, 723, 412	29, 874, 900	177, 934, 904	65, 248, 900	388, 622, 448	247, 209, 300	1, 472, 378, 591
1886.....	110, 874, 300	660, 367, 331	27, 331, 100	162, 784, 032	95, 580, 600	569, 278, 054	288, 775, 600	1, 719, 947, 474
1887.....	124, 999, 400	744, 496, 426	47, 645, 200	283, 774, 811	103, 385, 600	615, 764, 634	329, 771, 900	1, 964, 121, 436
1888.....	125, 649, 300	748, 367, 231	52, 689, 500	313, 818, 662	94, 365, 200	562, 039, 131	332, 203, 000	1, 978, 601, 068
1889.....	94, 844, 700	564, 895, 033	34, 186, 600	203, 615, 390	87, 136, 100	518, 982, 612	260, 091, 300	1, 549, 103, 783
1890.....	113, 065, 700	673, 419, 309	35, 759, 000	212, 980, 604	90, 814, 000	540, 888, 184	292, 314, 200	1, 741, 023, 375
1891.....	90, 100, 000	536, 635, 600	30, 700, 000	182, 849, 200	73, 300, 000	436, 574, 800	236, 700, 000	1, 409, 785, 200

The official report says that the shortage of rye approximates very nearly that of 1880, 1883, and 1889, and as to other grains, that of 1880 and 1885. The smallest rye crop in twelve years was in 1880, the largest in 1888. The aggregate rose above 700,000,000 bushels in three different years. In the first half of the decade, 1880-'84, the average yield of rye was 503,736,379 bushels; in the second, 574,185,600, an increase of 14 per cent. In wheat there was no increase, as three of the five years of the second half produced short crops. Taking all the cereals together, the first half averaged 1,419,349,860 bushels per annum; the second, 1,458,051,100 bushels.

Perhaps the fairest way of showing the shortage of 1891 is by comparison with the eleven previous years, the longest period of continued official record and as far back as the officials appear to indorse the approximate accuracy of Russian crop statistics. Some allowance should be made for a tendency to increase of acreage, which would make the relative deficiency larger than the figures indicate. The comparison is as follows:

	Rye.	Wheat.	Oats.	All cereals.
1880-1890..........................bushels..	644, 865, 692	228, 164, 296	538, 673, 556	1, 716, 256, 681
1891..........................do....	536, 635, 600	182, 849, 200	436, 574, 800	1, 409, 785, 200
Deficiency..............................	108, 230, 092	45, 315, 096	102, 098, 756	306, 471, 481

This deficiency is 16.8 per cent for rye, 19.9 for wheat, 19 for oats, and 17.9 per cent for all cereals together. The Russian Government

claims that there is a sufficiency of cereals in the country for subsistence of the people until the next crop comes in. There was a considerable export prior to the issue of the ukase forbidding it. It is claimed that stocks intended for sale and shipment are still held on speculation. If the aggregate supplies should be equal to consumption, it is a difficult if not a practically impossible task to distribute them so equally and promptly as to relieve the imminence of starvation of multitudes of poor people. Many of the districts most deficient have few if any railroad facilities, adding to the difficulty of affording relief.

The Russian Government is putting forth earnest efforts and making commendable progress in collection of crop statistics, but labors under the same difficulty that in less degree perhaps militates against our own success in that direction—the failure of a class of the population to realize the importance of such work and their inability to make sufficiently intelligent and accurate returns, and sometimes their hostility to any publicity of crop returns, from a mistaken notion that it places them in the hands of speculators, whereas it furnishes the most potent and effective safeguard against the results of speculation.

NUMBERS AND VALUES OF FARM ANIMALS.

The report of increase or decrease of farm animals and average prices of each kind of all ages is made on the 1st day of January of each year, and published in the January-February report. The following statement is a comparison of the aggregates of numbers of the several kinds of domestic animals in 1890 and 1891:

Stock.	1890.	1891.	Increase or decrease
Horses	14, 213, 837	14, 056, 750	—157, 087
Mules	2, 331, 027	2, 296, 532	— 34, 495
Milch cows	15, 952, 883	16, 019, 591	+ 66, 708
Oxen and other cattle	36, 849, 024	36, 875, 648	+ 26, 624
Sheep	44, 336, 072	43, 431, 136	—904, 936
Swine	51, 602, 780	50, 625, 106	—977, 674

There was a slight reduction of values reported in January of 1891, as compared with the prices of the previous year. In cattle, and especially in swine, this decline was due to reduction in average quality rather than to the lower price of meat. The scarcity and high price of corn forced such numbers of poorly fattened animals upon the market as to reduce temporarily the price of all. During the past year, however, prices in the principal markets, for meats particularly, have advanced, and doubtless the farm values will show larger averages than these reported below:

Stock.	1890.	1891.	Increase or decrease.
Horses	$68. 84	$67. 00	—$1. 84
Mules	78. 25	77. 88	— . 37
Milch cows	22. 14	21. 62	— . 52
Oxen and other cattle	15. 21	14. 76	— . 45
Sheep	2. 27	2. 50	+ . 23
Swine	4. 72	4. 15	— . 57

Estimated number of animals on farms and ranches, total value of each kind, and average price, January, 1891.

States and Territories.	Horses.			Mules.			Milch cows.		
	Number.	Average price.	Value.	Number.	Average price.	Value.	Number.	Average price.	Value.
Maine	100, 654	$93. 23	$9, 383, 978				172, 430	$26. 40	$4, 552, 152
New Hampshire	52, 926	86. 90	4, 599, 294				104, 041	26. 50	2, 757, 087
Vermont	84, 353	79. 03	6, 666, 246				234. 642	23. 50	5, 514, 087
Massachusetts	63, 200	106. 37	6, 722, 394				176, 476	32. 40	5, 717, 822
Rhode Island	10, 258	107. 13	1, 098, 980				24, 281	33. 00	801, 273
Connecticut	51, 376	102. 78	5, 280, 652				134, 897	32. 00	4, 316, 704
New York	640, 253	93. 45	59, 831, 055	5, 288	$96. 42	$509, 882	1, 536, 849	27. 21	41. 817, 661
New Jersey	97, 257	101. 77	9, 898, 090	9, 406	117. 11	1, 101, 494	185, 328	34. 00	6, 301, 152
Pennsylvania	570, 515	91. 04	51, 937, 861	24, 021	104. 69	2, 514, 778	919, 892	26. 67	24, 533, 520
Delaware	23, 000	87. 32	2, 008, 369	4, 184	111. 05	464, 654	29, 543	24. 50	723, 804
Maryland	126, 394	80. 14	10, 129, 235	13, 623	104. 56	1, 424, 457	143, 244	25. 00	3, 581, 100
Virginia	243, 758	72. 95	17, 781, 396	36, 444	88. 21	3, 214, 853	277, 477	21. 69	6, 018, 476
North Carolina	146, 518	78. 25	11, 464, 957	98, 221	88. 94	8, 735, 326	266, 712	17. 50	4, 667, 460
South Carolina	68, 897	89. 49	6, 165, 754	79, 269	98. 02	7, 770, 216	156, 575	21. 23	3. 324, 087
Georgia	112, 160	83. 84	9, 403, 231	157, 257	95. 97	15, 092, 208	351, 072	18. 10	6, 354, 403
Florida	34, 737	71. 40	2, 480, 361	12, 350	91. 49	1, 129, 894	54, 951	16. 50	906, 692
Alabama	133, 457	73. 64	9, 828, 262	143, 258	89. 46	12, 815, 875	308, 687	15. 90	4, 908, 123
Mississippi	135, 284	66. 15	8, 948, 373	186, 614	85. 10	15, 880, 261	306, 142	15. 50	4, 745, 201
Louisiana	122, 157	53. 83	6, 575, 443	95, 733	83. 04	7, 949, 274	175, 837	17. 00	2, 989, 229
Texas	1, 512, 385	32. 80	49, 613, 323	215, 277	55. 43	11, 932, 965	851, 775	14. 13	12, 035, 581
Arkansas	190, 896	55. 11	10, 519, 901	132, 463	67. 55	8, 947, 576	329, 121	13. 75	4, 525, 414
Tennessee	300, 174	70. 65	21, 207, 056	224, 661	73. 67	16, 551, 569	366, 408	16. 61	6, 086, 037
West Virginia	146, 647	67. 55	9, 905, 641	6, 867	75. 36	517, 512	181, 738	22. 50	4, 089, 105
Kentucky	394, 483	74. 39	29, 346, 700	148, 065	73. 26	10, 847, 737	317, 093	21. 00	6, 658, 953
Ohio	779, 323	77. 67	60, 529, 985	23, 983	83. 37	1, 999, 493	783, 403	24. 00	18, 801, 672
Michigan	472, 633	81. 18	38, 366, 437	6, 095	93. 90	572, 323	459, 475	25. 18	11, 569, 581
Indiana	647, 550	78. 35	50, 735, 543	51, 674	79. 20	4, 092, 736	608, 378	21. 50	13, 080, 127
Illinois	1, 123, 973	70. 48	79, 214, 809	94, 554	75. 96	7, 182, 792	1, 093, 922	22. 00	24, 066, 284
Wisconsin	433, 442	73. 27	31, 757, 833	6, 359	86. 30	548, 797	694, 826	21. 50	14, 938, 759
Minnesota	390, 835	76. 06	29, 728, 397	11, 412	88. 03	1, 004, 563	565, 935	20. 50	11, 601, 668
Iowa	1, 095, 300	70. 05	76, 726, 750	42, 739	77. 74	3, 322, 618	1, 278, 612	18. 75	23, 973, 975
Missouri	805, 564	57. 81	46, 573, 503	237, 000	65. 94	15, 627, 401	812. 828	17. 00	13, 818, 076
Kansas	748, 108	58. 27	43, 588, 517	89, 978	72. 68	6, 539, 343	758, 323	18. 30	13, 877, 311
Nebraska	558, 297	62. 97	35, 158, 748	45, 792	79. 55	3, 642, 780	424, 270	18. 50	7, 848, 995
California	360, 921	67. 22	24, 262, 579	43, 659	79. 41	3, 467, 093	282, 059	29. 00	8, 179, 711
Oregon	181, 236	47. 44	8, 598, 230	3, 647	62. 69	228, 618	102. 040	28. 50	2, 908. 140
Nevada	48, 947	48. 13	2, 355, 589	1, 777	68. 61	121, 912	16, 559	31. 00	513. 329
Colorado	124, 052	53. 75	6, 667, 661	4, 800	83. 67	401, 616	62, 285	28. 11	1, 750, 831
Arizona	31, 037	45. 00	1, 396, 665	2, 055	60. 00	123, 300	16, 790	27. 50	461. 725
Dakota	237, 244	65. 25	15, 480, 665	17, 016	86. 50	1, 471, 918	211, 326	18. 25	3, 856, 700
Idaho	89, 612	40. 00	3, 584, 480	1, 738	51. 00	88, 638	32, 068	29. 00	929, 972
Montana	151, 547	39. 45	5, 978, 527	1, 838	53. 01	97, 424	34, 005	28. 67	974, 923
New Mexico	33, 504	31. 02	1, 039, 255	9, 750	46. 40	452, 421	19, 356	20. 00	387, 120
Utah	90, 609	36. 59	3, 315, 151	4, 055	43. 75	177, 397	52, 910	20. 80	1, 100, 528
Washington	148, 291	70. 03	10, 384, 819	1, 306	89. 50	116, 893	92, 005	37. 00	3, 404, 185
Wyoming	142, 986	39. 04	5, 582, 536	2, 304	72. 38	166, 763	13, 005	33. 00	429, 165
Total	14, 056, 750	67. 00	941, 823, 222	2, 296, 532	77. 88	178, 847, 370	16, 019, 591	21. 62	346, 397, 900

States and Territories.	Oxen and other cattle.			Sheep.			Hogs.		
	Number.	Average price.	Value.	Number.	Average price.	Value.	Number.	Average price.	Value.
Maine	157, 386	$23. 94	$3, 767, 040	547, 670	$3. 11	$1, 700, 516	78, 253	$8. 20	$641, 678
New Hampshire	116, 169	22. 87	2, 657, 092	183, 183	2. 93	536, 909	52, 186	7. 88	410, 969
Vermont	167, 362	21. 41	3. 582, 884	351, 249	3. 12	1, 096, 038	75, 551	7. 34	554, 219
Massachusetts	96, 799	26. 32	2, 548, 136	55, 965	3. 73	208, 470	67, 208	9. 21	619, 067
Rhode Island	11, 950	26. 67	318, 713	20, 433	4. 06	83, 009	13, 796	8. 50	117, 265
Connecticut	101, 122	28. 64	2, 896. 129	45, 824	4. 13	189, 308	55, 042	9. 05	498, 128
New York	783, 634	26. 95	21, 118, 774	1, 393, 583	3. 81	5, 313, 035	672, 595	6. 55	4. 404. 558
New Jersey	65, 820	28. 06	1, 846, 867	100, 075	3. 95	395, 497	194, 436	8. 40	1, 633, 653
Pennsylvania	835, 222	22. 71	18, 965. 976	1, 039. 502	3. 71	3, 858, 631	1, 157, 613	7. 20	8, 334. 815
Delaware	26, 866	21. 17	568, 627	22, 517	3. 58	80, 701	51, 185	5. 52	282. 541
Maryland	124, 788	20. 15	2, 514, 164	156. 838	3. 67	575, 752	346, 510	5. 14	1, 781, 930
Virginia	419, 523	16. 63	6, 976, 457	444. 563	2. 89	1, 283, 720	969, 273	3. 54	3, 426, 381
North Carolina	390, 446	11. 12	4, 343, 440	398. 226	1. 70	678, 975	1, 291, 893	3. 36	4, 343. 343
South Carolina	208, 292	12. 54	2, 613, 023	98, 970	1. 82	180, 125	670, 652	3. 92	2, 628. 957
Georgia	569, 200	9. 87	5, 618. 573	383, 017	1. 72	658, 023	1, 610, 738	3. 08	4, 963. 651
Florida	548. 245	8. 78	4, 815, 620	111, 455	1. 83	203, 784	361, 601	2. 20	795, 521
Alabama	449, 502	9. 17	4, 123, 061	274. 788	1. 56	427, 873	1, 514, 701	2. 86	4, 338, 102
Mississippi	424, 188	8. 90	3. 774, 258	235, 345	1. 49	350, 899	1, 371, 622	2. 65	3, 630, 682
Louisiana	295, 731	9. 59	2, 837, 033	113, 931	1. 60	182, 825	706, 947	3. 17	2, 243, 850
Texas	7, 024, 496	8. 89	62, 444, 260	4, 990, 272	1. 52	7, 601, 682	2, 321, 246	2. 83	6, 569, 126
Arkansas	704, 654	8. 46	5, 961, 934	269, 484	1. 47	395, 737	1, 679, 908	2. 19	3, 672, 278

Estimated number of animals on farms, total value of each kind, etc.—Continued.

States and Territories.	Oxen and other cattle.			Sheep.			Hogs.		
	Number.	Average price.	Value.	Number.	Average price.	Value.	Number.	Average price.	Value.
Tennessee	460, 349	$10. 42	$4, 798, 495	511, 118	$2. 07	$1, 055, 663	2, 287, 059	$3. 32	$7, 590, 293
West Virginia	286, 538	18. 32	5, 248, 402	518, 827	2. 81	1, 458, 423	476, 501	3. 62	1, 723, 599
Kentucky	476, 592	16. 73	7, 974, 869	765, 679	3. 13	2, 399, 485	2, 300, 204	3. 66	8, 413, 686
Ohio	917, 539	21. 49	19, 714, 982	4, 061, 897	3. 25	13, 189, 386	2, 741, 565	4. 19	11, 489, 352
Michigan	503, 899	20. 15	10, 155, 165	2, 263, 249	3. 25	7, 348, 316	910, 242	4. 48	4, 073, 334
Indiana	1, 053, 627	18. 07	19, 041, 149	1, 150, 200	3. 58	4, 114, 151	2. 560, 772	4. 76	12, 191, 323
Illinois	1, 765. 385	17. 92	31, 628, 292	770, 993	3. 19	2, 456, 769	4. 944, 258	4. 98	24, 602, 627
Wisconsin	845, 429	16. 28	13, 761, 979	889, 910	2. 92	2, 597, 114	1. 109, 660	5. 25	5, 831, 263
Minnesota	617, 256	15. 19	9, 377, 356	330, 649	2. 67	881, 245	538, 077	5. 50	2, 961, 037
Iowa	2, 680, 247	17. 55	47, 038, 341	452, 025	3. 17	1, 430, 750	5, 921, 100	4. 98	29, 475, 236
Missouri	1, 819, 122	15. 07	27. 412, 175	898, 650	2. 42	2, 173. 834	4, 586, 400	3. 40	15, 612, 106
Kansas	1, 920, 893	16. 75	32, 168. 437	447, 079	2. 25	1, 007, 046	3, 144. 324	3. 98	12. 516, 295
Nebraska	1, 345, 563	16. 73	22, 507, 902	234, 612	2. 34	548, 171	2, 309, 779	4. 23	9, 772, 676
California	558, 244	17. 73	9, 895, 321	3, 712, 310	2. 20	8, 157, 801	517, 600	5. 26	2, 723, 611
Oregon	724, 592	17. 20	12, 463, 782	2, 431, 759	2. 12	5, 154, 114	229, 639	4. 08	936, 928
Nevada	317, 498	15. 46	4, 909, 789	504, 710	2. 35	1, 187, 835	12, 501	6. 15	76, 879
Colorado	1, 017, 465	15. 77	16, 046, 133	1, 819, 569	2. 37	4, 306, 555	23, 606	5. 35	126, 353
Arizona	725, 004	14. 00	10, 150, 056	593, 643	2. 25	1, 335, 697	20, 140	5. 30	106, 742
Dakota	739, 815	15. 91	11, 771, 792	274, 319	3. 16	866, 520	428. 912	5. 03	2, 155, 285
Idaho	381, 732	14. 25	5, 439, 681	501, 978	2. 30	1, 154, 549	34. 100	7. 00	238, 700
Montana	932, 697	15. 27	14, 242, 293	2, 089, 337	2. 37	4, 948, 595	35, 105	7. 13	250, 302
New Mexico	1, 341, 856	11. 01	14, 771, 151	3, 123, 663	1. 69	5, 268, 057	24, 852	5. 50	136, 688
Utah	383, 553	13. 71	5, 258, 518	2, 055, 900	2. 47	5, 070, 261	47, 641	7. 36	350, 640
Washington	443, 257	20. 97	9, 293, 106	673, 060	2. 62	1, 763, 687	147, 713	6. 01	888. 052
Wyoming	1, 096, 101	13. 47	14, 766, 681	1, 119, 110	2. 25	2, 521, 914	10, 400	5. 79	60, 211
Total	36, 875, 648	14. 76	544, 127, 908	43, 431, 136	2. 50	108, 397, 447	50, 625, 106	4. 15	210, 193, 923

Since those returns were made the tendency has been to increase of values in sheep and swine and a revival of interest in those branches of farm economy. A decided interest is manifested in the care and improvement of flocks, and a more hopeful feeling prevails due to a greater confidence in the stability and fair administration of laws affecting sheep husbandry. The reopening of European ports to the pork products has had a stimulating effect upon production, trade, and prices. A future of enlargement and prosperity evidently awaits this industry. The cattle industries are also affected favorably by the enlargement of consumption at home and demand from abroad.

NUMBERS AND VALUES JANUARY 1, 1892.

The returns of January, 1892, showing numbers and values by comparison with results of the previous January investigation, indicate an increase in numbers of farm animals.

A slight increase in value appears in store cattle and beeves, sheep and swine, a decline of 1 per cent in the price of cows, 2 per cent in horses, and 3 per cent in mules.

In Texas, Georgia, and South Carolina the value of horses is well sustained. In most of the Southern States there is a decline. In the Ohio Valley the reduction is greater than in the northern tier of States. Prices of Rocky Mountain herds are also lower.

Prices of cows are somewhat higher in New England, Virginia, North Carolina, and Georgia, with decline in Connecticut, New York, and Pennsylvania. There is little change in the States of the Ohio Valley, but some reduction in Michigan, Wisconsin, Minnesota, and Iowa. Values of other cattle have slightly improved in New England and in several of the central States of the West, while declining a little in some of the States of the Northwest. The increase in value of sheep, though not locally equal, is very general throughout the country.

Estimated number of animals on farms and ranches, total value of each kind, and average price, January, 1892.

HORSES AND MULES.

States and Territories.	Horses.			Mules.		
	Number.	Average price.	Value.	Number.	Average price.	Value.
Maine	110,719	$89.06	$9,860,299			
New Hampshire	53,985	82.32	4,443,906			
Vermont	90,258	76.38	6,894,201			
Massachusetts	64,464	104.36	6,727,722			
Rhode Island	10,361	104.51	1,082,840			
Connecticut	46,238	102.14	4,722,872			
New York	659,461	89.36	58,926,968	5,182	$99.30	$514,586
New Jersey	87,531	100.34	8,782,860	8,465	113.76	962,987
Pennsylvania	621,861	83.41	51,867,769	29,065	101.95	2,963,207
Delaware	25,300	84.77	2,144,681	4,812	107.07	515,205
Maryland	131,450	79.81	10,490,907	13,487	105.52	1,423,097
Virginia	246,196	74.77	18,407,152	37,173	89.30	3,319,391
North Carolina	131,866	78.62	10,366,953	100,185	88.13	8,828,881
South Carolina	60,629	87.18	5,285,433	86,403	95.57	8,257,164
Georgia	104,309	81.02	8,450,807	157,257	94.86	14,916,959
Florida	32,653	67.59	2,207,111	10,498	89.74	942,127
Alabama	121,446	69.87	8,485,421	136,095	86.58	11,783,744
Mississippi	155,577	62.56	9,733,285	162,354	81.82	13,283,547
Louisiana	127,043	51.65	6,562,241	91,904	81.76	7,514,451
Texas	1,209,908	31.48	38,092,747	230,239	53.30	12,272,852
Arkansas	187,078	55.37	10,359,133	135,112	68.48	9,252,333
Tennessee	312,181	68.94	21,522,778	222,414	71.45	15,891,399
West Virginia	155,446	65.73	10,216,770	7,210	73.21	527,829
Kentucky	402,373	69.32	27,890,626	151,026	69.34	10,472,211
Ohio	888,428	75.03	66,658,761	18,947	81.61	1,546,195
Michigan	519,896	78.40	40,757,393	3,779	93.67	353,991
Indiana	725,256	73.61	53,388,703	56,841	76.39	4,342,014
Illinois	1,337,528	68.69	91,872,771	106,846	72.38	7,733,399
Wisconsin	463,783	74.26	34,441,649	5,342	82.15	438,819
Minnesota	461,185	76.56	35,309,345	10,271	84.65	869,410
Iowa	1,314,360	66.13	86,921,929	41,029	73.01	2,995,598
Missouri	950,566	57.75	54,892,332	248,850	63.94	15,911,487
Kansas	935,135	59.18	55,344,187	92,677	71.85	6,658,989
Nebraska	625,293	58.05	36,298,768	46,708	74.36	3,473,182
California	415,059	62.67	26,010,045	54,574	74.72	4,077,548
Oregon	226,545	43.75	9,911,171	4,741	59.34	281,343
Nevada	57,757	42.80	2,471,975	1,688	64.01	108,051
Colorado	161,268	51.71	8,339,066	5,184	79.81	413,744
Arizona	51,658	40.00	2,066,320	1,336	56.00	74,816
North Dakota	142,000	70.73	10,044,001	8,000	89.55	716,372
South Dakota	260,000	65.98	17,154,826	8,200	81.98	672,274
Idaho	185,497	35.00	6,492,395	1,043	45.00	46,935
Montana	197,011	36.20	7,131,796	1,231	47.16	58,053
New Mexico	93,000	29.09	2,704,905	3,750	43.31	162,413
Utah	67,957	35.54	2,414,946	2,028	54.92	111,369
Washington	170,535	58.75	10,018,740	1,371	70.10	96,108
Wyoming	100,090	34.19	3,422,190	1,382	70.94	98,040
Total	15,498,140	65.01	1,007,593,636	2,314,699	75.55	174,882,070

MILCH COWS, OXEN, AND OTHER CATTLE.

States and Territories.	Milch cows.			Oxen and other cattle.		
	Number.	Average price.	Value.	Number.	Average price.	Value.
Maine	175,879	$26.50	$4,660,794	152,664	$24.74	$3,776,920
New Hampshire	106,122	26.50	2,812,233	113,846	23.48	2,673,550
Vermont	239,335	24.33	5,823,021	165,688	22.26	3,687,798
Massachusetts	176,476	32.72	5,774,295	96,799	25.78	2,495,797
Rhode Island	24,524	32.00	784,768	11,950	28.73	343,269
Connecticut	136,246	29.14	3,970,208	100,111	29.03	2,905,812
New York	1,552,217	26.18	40,637,041	775,798	26.67	20,693,631
New Jersey	189,035	35.00	6,616,225	63,845	28.75	1,835,731
Pennsylvania	929,091	25.25	23,459,548	835,222	22.17	18,514,790
Delaware	31,020	25.75	798,765	27,941	23.33	651,941
Maryland	147,541	26.21	3,867,050	121,044	21.79	2,637,323
Virginia	280,252	22.25	6,235,607	419,523	17.24	7,233,456
North Carolina	269,379	17.60	4,741,070	390,446	11.59	4,526,990
South Carolina	155,009	20.31	3,148,233	204,126	12.88	2,629,043
Georgia	354,583	18.00	6,382,494	569,200	9.86	5,613,450

Estimated number of animals on farms and ranches, total value of each kind, etc.—Cont'd.

MILCH COWS, OXEN, AND OTHER CATTLE.

States and Territories.	Milch cows.			Oxen and other cattle.		
	Number.	Average price.	Value.	Number.	Average price.	Value.
Florida	56, 600	$15. 00	$849, 000	553, 727	$9. 02	$4, 994, 120
Alabama	311, 774	15. 00	4, 676, 610	445, 007	9. 00	4, 006, 179
Mississippi	312, 265	14. 75	4, 605, 909	419, 946	7. 97	3, 346, 971
Louisiana	179, 354	17. 10	3, 066, 953	298, 688	10. 01	2, 989, 123
Texas	868, 811	14. 25	12, 380, 557	7, 024, 496	8. 85	62, 177, 330
Arkansas	342, 286	13. 75	4, 706, 433	725, 794	8. 75	6, 353, 236
Tennessee	373, 736	16. 50	6, 166, 644	469, 556	10. 48	4, 921, 187
West Virginia	183, 555	22. 71	4, 168, 534	292, 269	18. 67	5, 455, 723
Kentucky	320, 264	21. 75	6, 965, 742	467, 060	16. 97	7, 923, 866
Ohio	783, 403	25. 00	19, 585, 075	871, 662	22. 44	19, 559, 404
Michigan	459, 475	24. 24	11, 137, 674	508, 938	20. 67	10, 521, 389
Indiana	657, 048	23. 25	15, 276, 366	1, 085, 236	19. 28	20, 925, 520
Illinois	1, 104, 861	22. 23	24, 561, 060	1, 747, 731	18. 88	32, 992, 610
Wisconsin	701, 774	20. 54	14, 414, 438	836, 975	16. 43	13, 749, 322
Minnesota	577, 254	19. 25	11, 112, 140	641, 946	15. 87	10, 187, 680
Iowa	1, 304, 184	18. 77	24, 479, 534	2, 707, 049	18. 76	50, 792, 352
Missouri	869, 726	17. 50	15, 220, 205	1, 928, 269	16. 50	31, 821, 846
Kansas	773, 489	18. 40	14, 232, 198	1, 978, 520	16. 78	33, 207, 282
Nebraska	530, 338	18. 75	9, 943, 838	1, 614, 676	16. 59	26, 780, 200
California	290, 521	26. 95	7, 829, 541	602, 904	17. 39	10, 481, 663
Oregon	106, 122	25. 00	2, 653, 050	797, 051	16. 42	13, 090, 374
Nevada	14, 903	27. 50	409, 833	317, 498	14. 77	4, 689, 446
Colorado	60, 416	26. 00	1, 570, 816	1, 037, 814	16. 49	17, 112, 302
Arizona	17, 797	25. 00	444. 925	761, 254	15. 00	11, 418, 810
North Dakota	65, 000	21. 19	1, 377, 350	272, 000	17. 17	4, 669, 587
South Dakota	133, 000	19. 00	2, 527, 000	410, 000	16. 25	6, 662, 500
Idaho	32, 709	27. 00	883, 143	515, 338	15. 25	7, 858, 905
Montana	35, 705	28. 75	1, 026, 519	1, 025, 967	16. 30	16, 725, 323
New Mexico	18, 775	20. 00	375. 500	1, 288, 182	11. 01	14, 179, 659
Utah	54, 497	22. 21	1, 210, 378	402, 731	14. 10	5, 679, 512
Washington	96, 605	35. 00	3, 381, 175	447, 690	20. 88	9, 345, 532
Wyoming	13, 395	32. 00	428, 640	1, 107, 062	14. 37	15, 910, 696
Total	16, 416, 351	21. 40	351, 378, 132	37, 651, 239	15. 16	570, 749, 155

SHEEP AND HOGS.

States and Territories.	Sheep.			Hogs.		
	Number.	Average price.	Value.	Number.	Average price.	Value.
Maine	569, 577	$3. 01	$1, 717, 274	76, 688	$8. 48	$650, 317
New Hampshire	188, 678	2. 87	540, 751	51, 664	8. 24	425, 711
Vermont	358, 274	3. 29	1, 179, 725	74, 795	7. 85	587, 412
Massachusetts	57, 644	3. 89	223, 947	66, 536	9. 80	652, 056
Rhode Island	20, 433	4. 35	88, 884	13, 658	8. 90	121, 559
Connecticut	47, 199	4. 08	192, 454	54, 492	9. 36	510, 260
New York	1, 421, 455	3. 80	5, 401, 529	672, 595	7. 49	5, 035, 721
New Jersey	102, 077	4. 05	413, 922	190, 547	9. 23	1, 758, 746
Pennsylvania	1, 091, 477	3. 83	4, 178, 173	1, 157, 613	7. 60	8, 792, 072
Delaware	22, 967	3. 87	88, 768	53, 232	6. 35	338, 022
Maryland	164, 680	3. 91	644, 558	349, 975	6. 00	2, 098, 449
Virginia	449, 009	3. 05	1, 370, 016	978, 966	3. 67	3, 596, 722
North Carolina	390, 261	1. 82	710, 275	1, 253, 136	3. 70	4, 639, 735
South Carolina	89, 073	1. 89	167, 903	684, 065	4. 13	2, 827, 924
Georgia	383, 017	1. 76	673, 956	1, 691, 275	3. 37	5, 692, 832
Florida	117, 028	2. 06	241, 499	386, 913	2. 28	883, 710
Alabama	269, 292	1. 65	443, 927	1, 499, 554	2. 91	4, 356, 205
Mississippi	223, 578	1. 50	335, 367	1, 357, 906	2. 71	3, 685, 357
Louisiana	118, 488	1. 61	191, 240	756, 433	3. 16	2, 390, 328
Texas	5, 040, 175	1. 55	7, 808, 239	2, 321, 246	3. 15	7, 311, 924
Arkansas	264, 094	1. 50	396, 537	1, 663, 109	2. 39	3, 978, 158
Tennessee	506, 007	2. 19	1, 105, 879	2, 287, 059	3. 38	7, 741, 239
West Virginia	529, 204	3. 11	1, 646, 354	481, 266	3. 81	1, 831, 698
Kentucky	773, 336	3. 18	2, 456, 889	2, 346, 208	3. 86	9, 066, 686
Ohio	4, 468, 087	3. 30	14, 724, 581	2, 851, 228	4. 65	13, 258, 212
Michigan	2, 353, 779	3. 21	7, 560, 338	892, 037	5. 17	4, 611, 833
Indiana	1, 161, 702	3. 70	4, 298, 762	2, 586, 380	4. 94	12, 787, 061
Illinois	848. 092	3. 57	3, 025, 314	4, 894, 815	5. 43	26, 582, 760
Wisconsin	907, 708	2. 96	2, 688, 630	1, 109, 660	5. 34	5, 925, 584
Minnesota	357, 101	2. 80	998, 598	591, 885	5. 79	3, 429, 384
Iowa	565, 031	3. 42	1, 933, 084	7, 105, 320	5. 86	41, 645, 703

Estimated number of animals on farms and ranches, total value of each kind, etc.—Cont'd.

SHEEP AND HOGS.

States and Territories.	Sheep.			Hogs.		
	Number.	Average price.	Value.	Number.	Average price.	Value.
Missouri	916,623	$2.57	$2,355,262	4,632,264	$3.58	$16,583,505
Kansas	469,433	2.34	1,096,595	3,175,767	4.76	15,128,718
Nebraska	269,804	2.56	690,887	2,586,952	5.23	13,537,521
California	4,083,541	2.42	9,884,211	512,424	5.35	2,741,675
Oregon	2,456,077	2.24	5,491,789	227,343	4.32	981,575
Nevada	504,710	2.49	1,256,223	12,626	6.82	86,107
Colorado	1,710,395	2.49	4,263,673	23,842	5.53	131,730
Arizona	611,452	2.30	1,406,340	20,140	5.40	108,756
North Dakota	320,000	3.22	1,030,400	95,000	6.33	601,160
South Dakota	270,000	3.08	831,060	275,000	5.70	1,567,500
Idaho	527,077	2.40	1,264,985	64,790	7.25	469,728
Montana	2,089,337	2.50	5,228,566	35,105	7.50	263,290
New Mexico	2,967,480	1.54	4,556,566	24,852	5.90	146,628
Utah	2,055,900	2.26	4,650,466	48,594	8.57	416,274
Washington	686,521	6.71	1,858,824	152,144	6.49	987,476
Wyoming	1,141,492	2.46	2,808,070	10,920	6.08	66,392
Total	44,938,365	2.58	116,121,270	52,398,019	4.60	241,031,415

COMMERCIAL MOVEMENT OF FARM ANIMALS.

The enlargement of the volume of distribution of domestic animals has been very rapid in recent years. The increase of population does not account for the rapidity of advance as measured by receipts and shipments recorded at the principal markets. There may have been some increase in the rate of consumption, a somewhat more generous use of meat in the popular dietary, yet the main cause of apparently abnormal increase of volume in the main channels of trade is due to the concentration of the trade in few hands, the drying up of small streams of supply from the agricultural areas of the older States, and a larger dependence on the great pastoral areas of the country beyond the Missouri. Formerly nearly every farmer was a meat-producer, and every village had its butcher; now the farmer has become a dairyman, the butcher is an agent for the sale of Western and Texas beef, and the consumer is in the clutches of a system which is relegating beef production to the Western wilds and a mixture of Spanish-English breeds.

The four markets which include nearly all Western distribution are Chicago, St. Louis, Kansas City, and Omaha. Of the receipts of 1891 Chicago furnishes 55 per cent, Kansas City 22, St. Louis 13, and Omaha 10. Twenty-one years ago, in 1870, 69 per cent of the receipts were shipped away; last year only 43. This difference is due to the canning and packing industries of those cities, without which the percentage of the greatly enlarged receipts required for local consumption would be diminished.

The increase has been heavy in all kinds of farm animals, nearly sevenfold (680 per cent) for receipts of cattle, while the shipments are nearly four times as much (387 per cent). The receipts of sheep are increased sixfold, and shipments 861 per cent, though only about four-tenths of the receipts are shipped. The hogs show a surprising increase, these markets having scarcely an existence twenty years ago, Chicago taking the prominence before enjoyed by Cincinnati. More than forty times as many were received in 1891 as in 1870. Receipts ran to 14,042,906, and shipments made an aggregate of 4,517,395.

Receipts and shipments of Western cities.

CATTLE.

Years.	Chicago.		St. Louis.		Kansas City.		Omaha.	
	Receipts.	Shipments.	Receipts.	Shipments.	Receipts.	Shipments.	Receipts.	Shipments.
1870	532, 964	391, 709	201, 422	129, 748	21, 000	No record.	....	....
1875	920, 843	696, 534	335, 742	216, 701	174, 754	126, 262	....	....
1880	1, 382, 477	886, 614	424, 720	228, 879	244, 709	194, 421	....	....
1885	1, 905, 518	744, 093	386, 320	233, 249	506, 627	402, 381	114, 163	83, 233
1886	1, 963, 900	704, 675	377, 550	212, 958	490, 971	370, 350	144, 457	73, 120
1887	2, 382, 008	791, 483	464, 828	277, 419	669, 224	483, 372	235, 723	151, 419
1888	2, 611, 543	968, 385	546, 875	336, 206	1, 056, 086	682, 622	340, 469	206, 064
1889	3, 023, 281	1, 259, 971	508, 190	297, 879	1, 220, 343	744, 510	467, 340	227, 921
1890	3, 484, 280	1, 260, 309	639, 014	361, 225	1, 472, 229	923, 552	606, 699	283, 880
1891	3, 250, 359	1, 066, 264	779, 499	464, 794	1, 270, 917	739, 093	593, 044	267, 730

Years.	Receipts.	Shipments.	Years.	Receipts.	Shipments.
1870	755, 386	521, 457	1887	3, 751, 783	1, 703, 693
1875	1, 431, 339	1, 039, 497	1888	4, 554, 973	2, 193, 277
1880	2, 051, 906	1, 309, 914	1889	5, 219, 154	2, 530, 281
1885	2, 912, 628	1, 462, 956	1890	6, 202, 222	2, 828, 966
1886	2, 976, 878	1, 361, 103	1891	5, 893, 819	2, 537, 881

SHEEP.

Years.	Chicago.		St. Louis.		Kansas City.		Omaha.	
	Receipts.	Shipments.	Receipts.	Shipments.	Receipts.	Shipments.	Receipts.	Shipments.
1870	349, 853	116, 711	94, 477	11, 649	....	....	....	....
1875	418, 948	243, 604	125, 679	37, 781	25, 327	17, 742	....	....
1880	335, 810	156, 510	205, 969	93, 522	50, 611	36, 285	....	....
1885	1, 003, 598	260, 277	362, 858	233, 391	221, 801	115, 755	18, 985	8, 408
1886	1, 008, 790	266, 912	328, 985	202, 728	172, 659	83, 234	40, 195	17, 728
1887	1, 360, 862	445, 094	417, 425	287, 018	209, 956	103, 126	76, 014	56, 444
1888	1, 515, 014	601, 241	456, 669	316, 676	351, 050	169, 932	158, 503	118, 208
1889	1, 832, 469	711, 315	358, 495	255, 375	370, 772	174, 851	159, 503	103, 250
1890	2, 182, 667	929, 854	358, 506	252, 151	535, 869	336, 207	156, 186	94, 464
1891	2, 153, 537	688, 205	402, 989	277, 886	386, 760	178, 271	170, 849	89, 416

Years.	Receipts.	Shipments.	Years.	Receipts.	Shipments.
1870	444, 330	128, 360	1887	2, 064, 257	891, 682
1875	569, 954	299, 130	1888	2, 481, 236	1, 206, 057
1880	592, 390	286, 317	1889	2, 721, 239	1, 244, 791
1885	1, 607, 242	617, 831	1890	3, 233, 228	1, 612, 676
1886	1, 550, 629	570, 602	1891	3, 114, 135	1, 233, 778

HOGS.

Years.	Chicago.		St. Louis.		Kansas City.		Omaha.	
	Receipts.	Shipments.	Receipts.	Shipments.	Receipts.	Shipments.	Receipts.	Shipments.
1870	1, 693, 158	924, 453	310, 850	17, 156	36, 000	No record.	....	....
1875	3, 912, 110	1, 582, 643	628, 569	126, 729	63, 350	15, 790	....	....
1880	7, 059, 355	1, 394, 990	1, 840, 684	770, 769	676, 477	152, 920	....	....
1885	6, 937, 535	1, 797, 446	1, 455, 535	789, 487	2, 358, 718	801, 162	130, 867	71, 919
1886	6, 718, 761	2, 090, 784	1, 264, 471	530, 362	2, 264, 484	538, 005	390, 487	187, 369
1887	5, 470, 952	1, 812, 001	1, 052, 240	324, 745	2, 423, 262	524, 492	1, 011, 706	140, 726
1888	4, 921, 712	1, 751, 829	929, 230	294, 869	2, 008, 984	413, 937	1, 283, 600	333, 228
1889	5, 988, 526	1, 786, 659	1, 120, 930	420, 310	2, 073, 910	331, 434	1, 206, 605	179, 916
1890	7, 663, 828	1, 985, 700	1, 359, 789	667, 832	2, 865, 171	558, 227	1, 673, 314	275, 638
1891	8, 650, 805	2, 962, 514	1, 380, 569	704, 378	2, 599, 109	605, 457	1, 462, 423	245, 046

Years.	Receipts.	Shipments.	Years.	Receipts.	Shipments.
1870	346, 850	17, 156	1887	9, 958, 160	2, 801, 964
1875	4, 604, 029	1, 725, 162	1888	9, 143, 526	2, 793, 863
1880	9, 576, 516	2, 318, 679	1889	10, 389, 971	2, 718, 319
1885	10, 882, 655	3, 460, 014	1890	13, 562, 102	3, 487, 397
1886	10, 638, 203	3, 346, 520	1891	14, 042, 906	4, 517, 395

Receipts of Eastern cities.

CATTLE.

Years.	New York.	Boston.	Philadelphia.	Baltimore.	Total.
1870	361,076	124,592	126,738	89,021	701,427
1875	457,057	145,285	152,830	112,679	867,851
1880	679,987	230,079	218,606	138,969	1,267,641
1885	562,447	112,995	194,644	90,870	960,956
1886	513,470	113,316	176,025	96,357	899,168
1887	498,048	99,584	122,297	85,166	796,495
1888	515,593	124,416	134,574	170,113	944,696
1889	638,937	167,342	150,482	205,479	1,162,240
1890	684,502	167,974	168,733	219,009	1,240,218
1891	653,556	164,278	....	183,385	....

SHEEP.

Years.	New York.	Boston.	Philadelphia.	Baltimore.	Total.
1870	1,463,878	450,997	682,000	175,000	2,771,875
1875	1,233,968	372,370	491,500	191,485	2,289,323
1880	1,656,955	476,785	623,494	248,047	3,005,281
1885	1,849,277	639,847	616,573	178,712	3,284,409
1886	1,997,751	524,089	583,579	219,645	3,125,064
1887	2,025,116	591,476	588,279	227,456	3,432,327
1888	1,882,763	538,490	594,612	438,910	3,454,775
1889	1,805,805	540,460	537,431	421,951	3,305,647
1890	1,798,615	583,545	511,142	381,025	3,274,327
1891	1,881,913	594,856	....	422,131	....

SWINE.

Years.	New York.	Boston.	Philadelphia.	Baltimore.	Total.
1870	889,625	189,330	189,500	300,000	1,568,455
1875	1,388,517	331,989	243,300	279,631	2,243,437
1880	1,719,137	691,839	346,960	336,867	3,094,803
1885	1,919,063	790,332	326,456	265,381	3,301,232
1886	1,980,656	930,787	333,849	323,643	3,568,935
1887	1,791,531	1,039,692	329,561	504,619	3,665,403
1888	1,549,837	1,063,827	344,719	613,959	3,572,342
1889	1,761,623	1,143,314	401,424	702,966	4,009,327
1890	2,126,446	1,231,173	465,094	837,167	4,659,880
1891	2,177,323	1,539,191	....	908,079	....

The increase of receipts has been slower in Eastern than in Western cities; in the former they represent local consumption and export, while in the latter the requirement of the canning industry is a very large element in distribution. In New York, in cattle the receipts have not been doubled in twenty years; in sheep the advance is quite limited; while in hogs the increase has been nearly 200 per cent.

MEAT EXPORTATION.

The evolution of meat exportation was slow from its early initiation up to a recent date. Salted meats and tallow were the only forms known for many decades. Forty years ago there was a considerable exportation of Texas and Florida cattle to Cuba and other West India islands. They were light in weight, thin in flesh, and low in price. In 1860 they averaged $17.59 in value. In the seventies a better quality of beeves—among the best, in fact—began to be shipped to Great Britain. In 1877 the fresh-beef shipments in refrigerator ships were first made.

In 1870 the value of all shipments of beeves and beef products was $6,194,626. In 1891 the total value was $65,533,564. In 1870 the number of pounds of beef products exported was only 64,240,829. In 1891 the aggregate was 507,229,428 pounds, or enough to require the slaughter of more than a million cattle which would average a net product of 500 pounds. The number of beeves exported increased from 27,530 in 1870, worth only $439,987, or $15.98 each, to 374,679, worth $30,445,249, or $81.26 each. In this short period more than ten times as many were shipped, while the value was more than seventy times greater.

Exports of beef products.

QUANTITY.

Years.	Beef products.				
	Salted or cured.	Fresh.	Canned.	Other, cured.	Tallow.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1870	26, 727, 773				37, 513, 056
1871	43, 880, 217				33, 859, 317
1872	26, 652, 094				76, 151, 218
1873	31, 605, 196				79, 170, 558
1874	36, 036, 537				101, 755, 631
1875	48, 243, 251				65, 461, 619
1876	36, 596, 150				72, 432, 775
1877	39, 155, 153	49, 210, 990			91, 472, 803
1878	38, 831, 379	54, 046, 771			85, 505, 919
1879	36, 950, 563	54, 025, 832			99, 963, 752
1880	45, 237, 472	84, 717, 194			110, 767, 627
1881	40, 698, 649	106, 004, 812			96, 403, 372
1882	45, 899, 737	69, 586, 466			50, 474, 210
1883	41, 680, 623	81, 064, 373			38, 810, 098
1884	42, 379, 911	120, 784, 064		641, 163	63, 091, 103
1885	48, 143, 711	115, 780, 830		572, 427	50, 431, 719
1886	58, 903, 370	99, 423, 362		824, 955	40, 919, 951
1887	36, 287, 188	83, 560, 874	43, 050, 588	192, 191	63, 278, 403
1888	48, 980, 269	93, 498, 273	40, 458, 375	83, 151	92, 483, 052
1889	55, 006, 399	137, 895, 391	51, 025, 254	194, 036	77, 844, 555
1890	97, 508, 419	173, 237, 596	82, 638, 507	102, 110	112, 745, 370
1891	90, 286, 979	194, 045, 638	109, 585, 727	1, 621, 833	111, 689, 251

VALUE.

Years.	Beef products.				
	Salted or cured.	Fresh.	Canned.	Other, cured.	Tallow.
	Dollars.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
1870	1, 939, 778				3, 814, 861
1871	3, 825, 666				3, 025, 035
1872	1, 870, 826				6, 973, 189
1873	2, 447, 481				7, 068, 471
1874	2, 956, 676				8, 135, 320
1875	4, 197, 956				5, 692, 203
1876	3, 186, 304				6, 734, 378
1877	2, 950, 952	4, 552, 523			7, 883, 616
1878	2, 973, 234	5, 009, 856			6, 695, 377
1879	2, 336, 378	4, 883, 080			6, 934, 940
1880	2, 881, 047	7, 441, 918			7, 689, 232
1881	2, 665, 761	9, 860, 284			6, 800, 628
1882	3, 902, 556	6, 768, 881			4, 015, 798
1883	3, 742, 282	8, 342, 131			3, 248, 749
1884	3, 202, 275	11, 987, 331	3, 173, 767	67, 758	4, 793, 375
1885	3, 619, 145	11, 199, 481	4, 214, 791	73, 895	3, 322, 476
1886	3, 544, 379	9, 291, 011	3, 436, 453	89, 593	2, 144, 499
1887	1, 972, 246	7, 228, 412	3, 462, 982	17, 942	2, 836, 300
1888	2, 608, 479	8, 231, 281	3, 339, 077	8, 579	4, 252, 653
1889	3, 043, 324	11, 481, 861	4, 375, 213	17, 819	3, 942, 024
1890	5, 250, 068	12, 862, 384	6, 787, 193	9, 223	5, 242, 158
1891	5, 048, 788	15, 322, 054	9, 068, 906	147, 518	5, 501, 049

Exports of live animals.

Years.	Cattle.		Sheep.		Hogs.	
	Number.	Value.	Number.	Value.	Number.	Value.
1870	27,530	$439,987	39,570	$95,193	12,058	$189,753
1871	20,530	403,491	45,465	86,888	8,770	61,390
1872	28,033	565,719	35,218	79,592	56,110	548,153
1873	35,455	695,957	66,717	107,698	99,720	787,402
1874	56,067	1,150,857	124,248	159,735	158,581	1,625,837
1875	57,211	1,103,085	124,416	183,898	64,979	739,215
1876	51,593	1,110,703	110,312	171,101	68,044	670,042
1877	50,001	1,593,080	179,017	234,480	65,107	699,180
1878	80,040	3,896,818	183,995	333,499	29,284	267,259
1879	136,720	8,379,200	215,680	1,082,938	75,129	700,262
1880	182,756	13,344,195	209,137	892,647	83,434	421,089
1881	185,707	14,304,103	179,919	762,932	77,456	572,138
1882	108,110	7,800,227	139,676	603,778	36,368	509,651
1883	104,444	8,341,431	337,251	1,154,856	16,129	272,517
1884	190,518	17,855,495	273,874	850,146	46,382	627,486
1885	135,890	12,906,690	234,509	512,568	55,025	579,180
1886	119,065	10,958,954	177,594	329,844	74,187	674,293
1887	106,459	9,172,136	121,701	254,725	75,383	564,753
1888	140,208	11,577,578	143,817	280,490	23,755	193,017
1889	205,786	16,616,917	128,852	366,181	45,128	356,764
1890	394,836	31,261,131	67,521	243,077	91,148	909,042
1891	374,679	30,445,249	60,947	261,109	95,654	1,146,630

Exports of pork products.

QUANTITY.

Years.	Bacon and hams.	Pork, salted.	Pork, fresh.	Lard.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
1870	38,968,256	24,639,831		35,808,530
1871	71,446,854	39,250,750		80,037,297
1872	246,208,143	57,169,518		199,651,660
1873	395,381,737	64,147,461		230,534,207
1874	347,405,405	70,482,379		205,527,471
1875	250,286,549	56,152,331		166,869,393
1876	327,730,172	54,195,118		168,405,839
1877	460,057,146	69,671,894		234,741,233
1878	592,814,351	71,889,255		342,667,920
1879	732,249,576	84,401,676		326,658,686
1880	759,773,109	95,949,780		374,979,286
1881	746,944,545	107,928,086		378,142,496
1882	468,026,640	80,447,466		250,367,740
1883	340,258,670	62,116,302		224,718,474
1884	389,499,368	60,363,313	185,417	265,094,719
1885	400,127,119	71,649,365	424,103	283,216,339
1886	419,788,796	87,196,966	70,749	293,728,019
1887	419,922,955	85,869,367	23,930	321,533,746
1888	375,439,683	58,836,966	63,187	297,740,007
1889	400,224,646	64,110,845	22,794	318,242,990
1890	608,490,956	79,788,868	279,463	471,083,598
1891	599,085,665	81,317,364	818,875	498,343,927

VALUE.

Years.	Bacon and hams.	Pork, salted.	Pork, fresh.	Lard.
1870	$6,123,113	$3,253,137		$5,933,397
1871	8,126,683	4,302,320		10,563,020
1872	21,126,592	4,122,308		20,177,619
1873	35,022,137	5,007,035		21,245,815
1874	33,383,908	5,808,712		19,308,019
1875	28,612,613	5,671,495		22,900,522
1876	39,664,456	5,744,022		22,429,485
1877	49,512,412	6,296,414		25,562,665
1878	51,752,068	4,913,657		30,014,254
1879	51,074,433	4,807,568		22,856,673
1880	50,987,623	5,930,252		27,920,367
1881	61,161,205	8,272,285		35,226,575
1882	46,675,774	7,201,270		28,975,902
1883	38,155,952	6,192,268		26,618,048
1884	39,684,845	4,749,658	$13,057	25,305,953
1885	37,083,948	5,177,136	26,807	22,595,219
1886	31,640,211	5,119,426	3,985	20,361,786
1887	33,314,670	5,640,094	1,233	22,703,921
1888	32,175,633	4,368,691	4,423	22,751,105
1889	34,651,847	4,733,415	1,662	27,329,173
1890	47,056,760	4,753,488	15,406	33,455,520
1891	45,650,674	4,787,343	56,358	34,414,323

AGRICULTURAL EXPORTS AND IMPORTS.

EXPORTS.

Articles.	1890. Quantities.	1890. Value.	1891. Quantities.	1891. Value.
Animals, living:				
Cattle .... number..	394,836	$31,261,131	374,679	$30,445,249
Hogs .... do ...	91,148	909,042	95,654	1,146,630
Horses .... do	3,501	680,410	3,110	784,908
Mules .... do	3,544	447,108	2,184	278,658
Sheep .... do	67,521	243,077	60,947	261,109
All other, and fowls	....	97,360	....	18,532
Animal matter:				
Bones, hoofs, horns, and horn tips, strips, and waste	....	271,533	....	335,710
Casings for sausages	....	697,772	....	841,075
Eggs .... dozen..	380,884	58,675	363,116	64,259
Glue .... pounds..	728,696	88,484	986,552	110,292
Grease, grease scraps, and all soap stock...	....	1,506,819	....	2,038,886
Hair, and manufactures of	....	344,558	....	394,544
Hides and skins other than furs	....	1,828,635	....	1,333,655
Honey	....	113,101	....	83,325
Oils:				
Lard .... gallons..	1,214,611	663,343	1,092,448	562,986
Other animal .... do	727,732	457,926	512,253	317,594
Meat products—				
Beef products—				
Beef, canned .... pounds..	82,638,507	6,787,193	109,585,727	9,068,906
Beef, fresh .... do	173,237,596	12,862,384	194,045,638	15,322,054
Beef, salted or pickled .... do	97,508,419	5,250,068	90,286,979	5,048,788
Beef, other, cured .... do	102,110	9,223	1,621,833	147,518
Tallow .... do	112,745,370	5,242,158	111,689,251	5,501,049
Mutton .... do	256,711	21,793	199,395	18,959
Oleomargarine—				
Imitation butter .... pounds..	2,535,926	297,264	1,986,743	255,024
The oil .... do	68,278,098	6,476,258	80,231,035	7,859,130
Pork products—				
Bacon .... pounds..	531,899,677	39,149,635	514,675,557	37,404,989
Hams .... do	76,591,279	7,907,125	84,410,108	8,245,685
Pork, fresh .... do	279,463	15,406	818,875	56,358
Pork, salted or cured .... do	79,788,868	4,753,488	81,317,364	4,787,343
Lard .... do	471,083,598	33,455,520	498,343,927	34,414,323
Poultry and game	....	23,365	....	15,808
All other meat products	....	931,770	....	1,007,757
Dairy products—				
Butter .... pounds..	29.748,042	4,187,489	15,187,114	2,197,106
Cheese .... do	95,376,053	8,591,042	82,133,876	7,405,376
Milk	....	303,325	....	261,298
Wax, bees' .... pounds..	171,391	19,727	120,548	30,027
Wool, raw .... do ...	231,042	33,543	291,922	39,423
Total value of animals and animal matter..	....	175,986,750	....	178,104,333
Bread and breadstuffs:				
Barley .... bushels..	1,048,311	754,605	973,062	669,203
Bread and biscuits .... pounds..	15,035,540	766,476	15,541,655	838,848
Corn .... bushels..	101,973,717	42,658,015	30,768,213	17,652,687
Cornmeal .... barrels..	361,248	896,879	318,329	946,977
Oats .... bushels..	13,692,776	4,510,055	953,010	405,708
Oatmeal .... pounds..	25,460.322	784,879	7,736,873	221,316
Rye .... bushels..	2,257,377	1,279,814	332,739	212,161
Rye flour .... barrels..	3,933	13,782	4,254	18,185
Wheat .... bushels..	54,387,767	45,275,906	55,131,948	51,420,272
Wheat flour .... barrels..	12,231,711	57,036,168	11,344,304	54,705,616
All other breadstuffs and preparations of, used as food	....	949,348	....	1,030,683
Total value of bread and breadstuffs......	....	154,925,927	....	128,121,656
Cotton and cotton-seed oil:				
Cotton—				
Sea island .... pounds..	9,220,819	2,280,717	14,588,092	3,062,968
Other unmanufactured .... do	2,462,579,034	248,688,075	2,892,770,703	287,649,930
Cotton-seed oil .... gallons..	13,384,385	5,291,178	11,003,160	3,975,305
Total value of cotton and cotton-seed oil..	....	256,259,970	....	294,688,203

EXPORTS—Continued.

Articles.	1890.		1891.	
	Quantities.	Value.	Quantities.	Value.
Miscellaneous:				
Broom corn		$111,147		$172,191
Fruits and nuts—				
Apples, dried ... pounds	20,861,462	1,038,682	6,973,168	409,605
Apples, green or ripe ... barrels	435,506	1,231,436	135,207	476,897
Fruits, preserved—				
Canned		698,321		703,830
Other		59,401		93,996
All other, green, ripe, or dried		1,003,846		699,798
Nuts		27,861		50,617
Hay ... tons	36,274	567,558	28,066	470,228
Hops ... pounds	7,540,854	1,110,571	8,736,080	2,327,474
Oil cake and oil-cake meal ... do	711,704,373	7,999,926	633,344,851	7,452,094
Oils—				
Linseed ... gallons	89,288	55,036	76,789	48,267
Other vegetable		102,792		93,429
Rice ... pounds	388,914	20,728	540,620	33,012
Seeds—				
Clover ... do	26,500,578	1,762,034	20,773,884	1,575,039
Cotton ... do	7,660,601	74,575	10,108,014	85,315
Flax seed or linseed ... bushels	14,678	19,792	144,848	184,564
Timothy ... pounds	11,051,053	473,770	8,757,788	370,151
All other		307,717		285,830
Tobacco—				
Leaf ... pounds	244,343,740	21,149,869	236,969,589	20,710,911
Stems and trimmings ... do	11,303,286	329,687	12,263,016	322,848
Vegetables—				
Onions ... bushels	80,275	72,760	57,182	79,993
Peas and beans ... do	261,212	558,317	251,063	473,006
Potatoes ... do	406,618	269,693	341,189	316,482
Canned		231,265		286,321
All other, including pickles		225,060		180,173
Wine—				
In bottles ... dozen	7,281	32,350	11,409	52,392
Not in bottles ... gallons	393,323	238,580	543,292	319,085
All other agricultural products		271,235		251,309
Total value of miscellaneous products		40,044,009		38,524,907

RECAPITULATION.

Animals and animal matter		175,986,750		178,104,333
Bread and breadstuffs		154,925,927		128,121,656
Cotton and cotton-seed oil		256,259,970		294,688,203
Miscellaneous products		40,044,009		38,524,907
Total agricultural exports		627,216,656		639,439,099
Total exports		845,293,828		872,270,283
Per cent of agricultural matter		74.2		73.3

IMPORTS.

Articles.	1889.	1890.	1891.
Sugar and molasses:			
Sugar	$88,543,971	$96,094,532	$105,728,216
Molasses	4,753,897	5,168,795	2,659,776
Sugar drainings	4,026	3,399	1,349
Total sugar and molasses	93,301,894	101,266,726	108,389,341
Tea, coffee, and cocoa:			
Tea	12,654,640	12,317,493	13,828,993
Coffee	74,724,882	78,267,432	96,123,777
Cocoa, and leaves and shells of	2,328,262	2,713,166	3,323,057
Unenumerated items	151,538	156,546	97,794
Total tea, coffee, and cocoa	89,859,322	93,454,637	113,373,621

IMPORTS—Continued.

Articles.	1889.	1890.	1891.
Animals and their products, except wool:			
Cattle	$703,469	$244,747	$102,978
Horses	4,868,862	4,840,485	3,265,254
Sheep	1,259,000	1,268,209	1,219,206
All other, and fowls	392,712	413,491	357,927
Bristles	1,284,724	1,286,219	1,357,938
Butter	24,577	13,679	58,541
Cheese	1,135,184	1,295,506	1,358,752
Eggs	2,418,976	2,074,912	1,185,595
Glue	454,460	471,829	497,340
Grease	212,198	264,089	430,335
Hair	2,585,941	3,026,566	2,408,733
Hides	25,127,750	21,881,886	27,930,759
Hide cuttings, etc	232,251	348,440	353,943
Hoofs, horns, etc	303,575	236,648	587,444
Meats—			
Preserved	329,411	407,038	521,322
All other	277,131	272,199	144,049
Milk	91,161	102,954	105,633
Oil, animal	3,677	6,471	5,531
Sausage skins	377,750	494,958	572,817
Unenumerated	797,061	743,590	813,873
Total animals and their products, except wool	42,879,870	39,693,916	43,277,970
Fibers:			
Animal—			
Wools	17,974,515	15,264,083	18,231,372
Silk, unmanufactured	19,333,229	24,331,867	19,086,436
Vegetable—			
Cotton	1,194,505	1,392,728	2,825,004
Flax	2,070,729	2,188,021	1,656,779
Hemp and all substitutes	9,433,774	7,341,956	7,949,650
Jute	2,853,664	3,249,926	3,862,858
Sisal grass and other vegetable substances	6,110,308	7,064,184	5,829,514
Fibers not elsewhere specified	483,212	697,680	1,987,904
Total fibers	59,453,936	61,530,445	61,429,517
Miscellaneous:			
Breadstuffs—			
Barley	7,723,838	5,629,849	3,222,593
Corn	1,216	908	1,651
Oats	10,178	8,950	5,056
Oatmeal	56,002	59,300	31,089
Rye	24	115,657	98,227
Wheat	119,017	112,303	431,940
Wheat flour	5,792	5,049	43,180
Breadstuffs and farinaceous substances not elsewhere specified	1,055,655	1,210,982	1,194,473
Chicory	216,573	209,283	342,517
Fruits and nuts	18,746,417	20,747,774	26,015,374
Hay	1,082,885	1,143,445	445,461
Hops	1,155,472	1,053,616	1,797,406
Indigo	2,684,105	1,827,937	1,600,630
Malt, barley	111,381	161,666	78,433
Oils, vegetable:			
Fixed or expressed—			
Olive	696,065	819,110	733,489
Other	1,108,854	1,340,551	1,465,001
Volatile or essential	1,183,005	1,061,631	1,523,491
Opium, crude	809,893	1,183,712	1,202,375
Plants, trees, and shrubs	325,331	343,226	189,763
Rice and rice meal	3,499,437	2,540,674	4,559,540
Seeds	5,097,223	4,089,814	3,266,230
Spices:			
Ground	173,668	249,077	262,682
Unground—			
Nutmegs	514,888	534,340	686,019
Pepper	1,578,421	1,619,215	1,338,637
All other	890,889	826,397	865,882
Tobacco, leaf	10,868,226	17,605,192	13,287,094
Vanilla beans	699,903	559,867	594,744
Vegetables:			
Beans and peas	786,343	1,307,702	2,078,571
Potatoes	321,106	1,365,898	2,797,927
Pickles and sauces	349,422	386,307	511,163
All other—			
In their natural state, or in salt or brine	431,227	896,028	1,067,757
Prepared or preserved	389,804	510,077	668,519

IMPORTS—Continued.

Articles.	1889.	1890.	1891.
Miscellaneous—Continued.			
Wines:			
Champagne and other sparkling	$4,254,413	$4,752,572	$5,615,872
Still wines—			
In casks	2,126,548	2,450,174	2,641,816
In bottles	1,325,811	1,657,210	1,749,372
Unenumerated items	156,486	161,528	177,523
Total miscellaneous	70,555,518	78,547,021	82,591,497
RECAPITULATION.			
Sugar and molasses	93,301,894	101,266,726	108,389,341
Tea, coffee, and cocoa	89,859,322	93,454,637	113,373,621
Animals and their products, except wool	42,879,870	39,693,916	43,277,970
Fibers, animal and vegetable	59,453,936	61,530,445	61,429,517
Miscellaneous	70,555,518	78,547,021	82,591,497
Total agricultural	356,050,540	374,492,745	409,061,946
Total imports	745,131,652	789,310,409	844,916,196
Per cent of agricultural matter	47.8	47.4	48.4

FOREIGN TARIFFS ON FARM PRODUCTS.

Farm products and primary manufactures therefrom are the principal items of our exports to foreign countries. The proportion of agricultural products in our total exports averages about 72 to 75 per cent each year, while almost one-half of our imports are of farm products.

Import duties are collected by all countries on the foreign produce which they purchase, varying as the products come into competition with their own agriculture. There are no absolute exceptions to this rule, though some have a larger free list than others. For purposes of comparison, the import duties in this country upon the principal farm products are given, together with similar duties in other countries. Under the present tariff the duties charged in this country are as follows:

Articles.	Duty.	Articles.	Duty.
Live animals:		Provisions—Continued.	
For breeding	Free.	Rice, cleaned ... per pound	$0.02
Horses and mules ... each	$30.00	Rice, uncleaned ... do	.0125
Horses and mules, if valued at $150 and over	(*)	Tobacco, leaf for cigar wrappers:	
Cattle more than 1 year old ... each	10.00	Stemmed ... do	2.00
Cattle less than 1 year old ... do	2.00	Unstemmed ... do	2.75
Hogs ... do	1.50	Raisins ... do	0.25
Sheep 1 year old ... do	1.50	Wool:	
Sheep less than 1 year old ... do	.75	Class 1 ... do	0.11
Breadstuffs:		Class 2 ... do	0.12
Barley ... per bushel	.30	Class 3	
Corn ... do	.15	Valued at 13 cents or less	(†)
Rye ... do	.10	Valued at more than 13 cents	(‡)
Wheat ... do	.25	Coffee	Free.
Provisions:		Cotton	Free.
Bacon and hams ... per pound	.05	Hides	Free.
Beef, mutton, pork, and lard ... do	.02	Jute and jute butts	Free.
Butter and cheese ... do	.06	Sugar:	
Eggs ... per dozen	.05	Above No. 16 Dutch standard, per pound	0.05
Potatoes ... per bushel	.25	All other	Free.

* Ad valorem, 30 per cent. † Ad valorem, 32 per cent. ‡ Ad valorem, 50 per cent.

Similar duties are levied in the principal European countries, as compiled from recent consular returns, as follows:

[100 kilos=220.4 pounds.]

Articles.	Duty.
Austria-Hungary.	
Live animals:	
Oxen.........per head..	$7.20
Steers.........do....	1.92
Hogs.........do....	1.44
Sheep.........do....	.24
Breadstuffs:	
Barley and oats.........per 100 kilos..	.36
Indian corn.........do....	.24
Rye, wheat, and malt.........do....	.72
Flour.........do....	1.80
Provisions:	
Meats of all kinds.........do....	2.88
Lard.........do....	7.60
Butter.........do....	4.80
Cheese.........do....	9.60
Tobacco, leaf.........do....	10.68
Vegetables, canned.........do....	19.20
Belgium.	
Live animals:	
Bulls and bull calves.........per kilo..	.00⅘
Oxen and bullocks.........do....	.01
Sheep.........per head..	.48
Breadstuffs.........	Free.
Provisions:	
Fresh meat (whole or half carcasses).........per kilo..	.03
All other meats, salted, smoked, etc..	Free.
Lard, butter, and cheese.........	Free.
Tobacco, leaf.........per 100 kilos..	13.50
Vegetables.........	Free.
Denmark.	
Live animals.........	Free.
Breadstuffs.........	Free.
Provisions:	
Meats—	
All sorts, except canned.........	Free.
Canned.........per 100 pounds..	4.00
Lard and butter.........	Free.
Oleomargarine.........per 100 pounds..	1.70
Cheese.........do....	2.78
Tobacco:	
Leaves and stems.........do....	4.00
Smoking, chewing, etc.........do....	5.60
Vegetables:	
Preserved in vinegar or salted..do....	.57
In cans.........do....	4.00
France.	
Live animals:	
Oxen.........per head..	7.33
Cows.........do....	3.86
Sheep.........do....	.96
Hogs.........do....	.19
Breadstuffs:	
Wheat.........per 100 kilos..	.97
Flour.........do....	1.54
Barley.........do....	.29
Rye.........do....	.58
Indian corn.........	Free.
Provisions:	
Meat—	
Fresh.........per 100 kilos..	2.32
Salted.........do....	1.64
Canned.........do....	1.54
Extracts.........do....	.77
Cheese—	
Soft.........per 100 kilos..	$1.16
Hard.........do....	1.54
Butter—	
Fresh.........do....	2.50
Salted.........do....	2.90
Lard.........	Free.
France—Continued.	
Tobacco (Government monopoly).........	Free.
Vegetables:	
Green.........	Free.
Preserved.........per 100 kilos..	$0.58
Germany.	
Live animals:	
Horses.........each..	4.76
Oxen.........do....	7.14
Sheep.........do....	.24
Breadstuffs:	
Wheat and rye.........per 100 kilos..	1.19
Oats.........do....	.95
Flour and corn meal.........do....	2.50
Buckwheat.........do....	.48
Barley.........do....	.54
Maize.........do....	.48
Malt.........do....	.95
Provisions:	
Butter and cheese.........do....	4.76
Meat, fresh and prepared.........do....	4.76
Fowl and game.........do....	7.10
Tobacco, leaf.........do....	20.23
Sugar, cane.........do....	7.14
Holland.	
Meats:	
Bacon, pork, and mutton—	
Salted.........	Free.
Dried, smoked, etc..per 100 kilos.	.40
Other than above—	
Salted.........do....	2.41
Dried, etc.........do....	3.21
Fruit:	
Fresh.........	(*)
Canned.........per 100 kilos..	7.24
Live animals.........	Free.
Cereals.........	Free.
Italy.	
Animals:	
Oxen.........per head..	7.33
Sheep.........do....	.57
Horses.........	Free.
Breadstuffs:	
Oats.........per 100 kilos..	.77
Rye.........per ton..	2.21
Wheat.........do....	9.66
Barley.........do....	2.21
Indian corn.........do....	2.21
Flour.........per 100 kilos..	1.68
Fruit:	
In sugar, etc.........do....	19.30
In own juices.........do....	3.86
Provisions:	
Meats—	
Fresh.........do....	2.31
Salted, smoked, etc.........do....	4.83
Lard.........do....	1.93
Butter—	
Fresh.........per 100 kilos..	2.31
Salted.........do....	3.38
Cheese.........do....	2.31
Poultry.........do....	.96
Portugal.	
Wheat.........per 100 kilos..	1.72
Flour.........do....	2.46
Other cereals.........do....	1.51
Cattle.........per head..	2.70
Hogs.........do....	1.64
Horses†.........	....

*5 per cent.

†2 per cent.

[100 kilos = 220.4 pounds.]

Articles.	Duty.	Articles.	Duty.
Portugal—Continued.		*Spain*—Continued.	
Butter .... per kilo..	$0.20	Salted and dried meats.... per 100 kilos..	$2.24
Lard .... do....	.11	Pork, lard, bacon, and hams .... do....	9.65
Cheese .... do....	.21	Other meats .... do....	3.47
Beef:		Rice:	
Dry .... do....	.03½	Cleaned .... do....	2.05
Other .... do....	.11	Uncleaned .... do....	1.02
Russia.		Wheat .... do....	1.54
		Flour:	
Flour .... per 36 pounds..	.06	Wheat .... do....	2.55
Starch .... do....	.60	Other .... do....	1.38
Rice:		Tobacco, in leaf .... per kilo..	3.12
Cleaned .... do....	.42½	*Sweden.*	
Uncleaned .... do....	.25	Cattle .... per head..	2.68
Meats .... do....	.47½	Sheep .... do....	.28
Cheese .... do....	3.00	Meats .... per 100 kilos..	.95
Butter and lard .... per 36 pounds..	0.25	Butter .... do....	2.72
Live animals	Free.	Lard .... do....	2.72
*Spain.**		Cheese .... do....	2.72
		Barley, rye, and wheat .... do....	.67
Cattle .... per head..	7.72	Flour .... do....	1.15
Swine .... do....	3.86	Indian meal .... do....	2.14
Sheep .... do....	.46	Oats .... do....	2.68

* All food imports are subject, also, to "transit and consumo duties."

The tariff rate in Turkey is 8 per cent ad valorem; American pork is prohibited.

In addition to the countries mentioned above, the following statement covering the import duties upon agricultural products in Switzerland, compiled from the returns published by the international customs tariffs bureau at Brussels, is presented, and includes the tariff laws of 1884 and 1887. In the case of many articles the duties under treaty stipulations with other countries are levied instead of the duties fixed by the tariff acts. In such cases the duty given below is the duty under such special treaties:

Articles.	Duty per 100 kilograms.	Articles.	Duty per 100 kilograms.
Lard	$0.58	Tobacco, leaves, not manufactured ...	$4.83
Butter	1.35	Horses and mules	.58
Eggs	.19	Colts and asses	.19
Butchers' meat, fresh	.58	Oxen and bulls	2.90
Meat, salted, smoked, etc., and bacon.	.77	Cows and heifers	2.32
Pork, butchers' meat (sausage, etc.) ..	2.32	Young cattle	.97
Potatoes	Free.	Calves	.58
Cereals, cleaned, crushed, etc., and flour of cereals	.39	Swine weighing 25 kilograms	.97
Cheese	.77	Swine weighing less than 25 kilograms	.58

A similar compilation of duties imposed in a number of the leading countries of the American continent is also presented:

Articles.	Duty.	Articles.	Duty.
*Mexico.**		*Mexico*—Continued.	
Live animals:		Breadstuffs:	
Geldings .... each..	$32.	Corn, gross weight ..... per pound..	$0.004
Horses, other .... do....	24.	Oats, gross weight .... do....	.004
Mules .... do....	4.	Wheat and other cereals, gross weight .... per pound..	.018
Cattle .... per pound..	.011	Flour, legal weight .... do....	.036
Swine .... do....	.011		
Sheep and goats .... each..	1.20		

* Reductions to English equivalents on basis of 80 cents per peso. Net weight means weight of the merchandise without coverings. Legal weight means weight of the goods, including interior wrappings. Gross weight means weight of the merchandise with all interior wrappings, outside cases, and packings.

Articles.	Duty.
Mexico—Continued.	
Provisions:	
Meats—	
Fresh ... per pound	$0.036
Smoked or salted, and hams, legal weight ... per pound	.073
Preserved, legal weight ... do	.055
Butter, legal weight ... do	.073
Cheese, legal weight ... do	.043
Eggs	Free.
Lard, net weight ... per pound	.073
Milk	Free.
Tobacco, leaf:	
Not Virginia, net weight, per pound	.498
Virginia, net weight ... do	.091
Wool, in fleece, net weight ... do	.036
Nicaragua. *	
Live animals	Free.
Provisions:	
Meats—	
Dried, smoked, or salted, ... per pound	.022
In brine in barrels ... do	.014
Preserved, including hams ... do	.059
Bacon and salt pork ... do	.029
Butter and cheese ... do	.059
Lard ... do	.037
Cotton, raw ... do	.022
Flour ... do	.007
Wool ... do	.074
Honduras.†	
Live animals	Free.
Breadstuffs:	
Oats	Free.
Flour	Free.
Rice	Free.
Provisions:	
Meats, and bacon not canned, ... per pound	.0145
Hams ... do	.029
Butter and cheese ... do	.029
Lard ... do	.029
Tallow ... do	.0145
Flax ... do	.0145
Tobacco, leaf ... do	.3625
Wool ... do	.029
Costa Rica.‡	
Breadstuffs:	
All cereals ... per pound	.007
Flour ... do	.013
Provisions:	
Bacon, in tins or otherwise, per pound	.023
Costa Rica—Continued.	
Provisions—Continued.	
Butter ... per pound	$0.013
Cheese ... do	.023
Hams, in tins or otherwise ... do	.023
Lard ... do	.013
Meats:	
All kinds, smoked, dried, or in tins ... per pound	.013
Preserved, potted, etc ... do	.023
Potatoes ... do	.007
Hay ... do	.007
Rice ... do	.023
Vegetables, fresh ... do	.007
Hides and skins ... do	.023
Sheepskins, dressed ... do	.037
Cotton, raw ... do	.013
Wool, raw ... do	.037
Ecuador.§	
Live animals	Free.
Breadstuffs:	
Barley, corn, and wheat ... per pound	.0067
Flour ... do	.0167
Provisions:	
Butter ... per pound	.0334
Hams and salt meats ... do	.0167
Sausages ... do	.1669
Lard ... do	.0334
Eggs	Free.
Potatoes ... per pound	.0033
Cotton, raw ... do	.0167
Hides ... do	.0033
Rice ... do	.0033
Tobacco, leaf ... do	.3338
Colombia.	
Animals, live	Free.
Hides and furs, unmanufactured, ... per pound	.067
Meats, smoked and pickled ... do	.067
Wool, raw ... do	.017
Flour ... do	.017
Potatoes, rice, fresh vegetables, and fruit ... per pound	.003
Tobacco, leaf ... do	.033
Argentine Republic.	
Breadstuffs:	
Corn ... per pound	.02189
Flour and meal ... do	.02189
Cotton, raw	Free.
Rice	‖
Tobacco, not Havana ... per pound	¶ .44

*Duties are on gross weight. Reductions to English equivalents at the rate of 73.6 cents per peso.
† Reductions to English equivalents on basis of 72.3 cents per peso.
‡ Reductions to English equivalents on basis of 73.6 cents per peso.
§ Reduction to English equivalents on basis of 73.6 cents per peso. In addition, extra duties amounting to 30 per cent are charged on duties expressed.
‖ Fifteen per cent ad valorem.
¶ And 60 per cent ad valorem.

DUTIES UNDER RECIPROCITY TREATIES.

Section 3 of the tariff act approved October 1, 1890, under which our duties are now levied, provided that, with a view to securing reciprocal trade with countries producing tea, coffee, sugar, molasses, and hides, raw and uncured, the President shall, when he shall be satisfied that the government of any country producing these articles imposes duties or other exactions upon products from the United States which, in view of the free introduction of sugar, molasses, coffee, tea, and hides into this country, shall be deemed reciprocally unequal and unreasonable, suspend the provisions of the tariff act allowing such free introduction of these articles, and during such suspension certain duties provided shall be levied, collected, and paid upon them.

Under this provision reciprocity treaties have been negotiated with a number of countries, and it is understood that others are approaching consummation. For the purpose of making plain the advantages which our agriculture will derive from these commercial arrangements, a statement of our trade in our farm products, together with our total trade with these countries, has been prepared. In addition, a showing of their regular tariff on our principal farm products, with the concessions under the treaties, is presented.

BRAZIL.

The Brazilian tariff rates, revised up to July 1, 1891, are as follows, 54 cents having been taken as the value of the milreis:

Articles.	Duty.	Articles.	Duty.
Live animals:		Provisions—Continued.	
Horses, mules, and asses ....each..	$10.80	Meats in brine or smoked..per pound..	$0.03
Neat cattle ....do....	2.70	Butter and cheese ....do....	.142
Sheep, goats, and swine ....do....	.38	Eggs ....do....	.04
Breadstuffs:		Lard, melted or prepared ....do....	.049
Barley ....per pound..	.0074	Tallow, crude ....do....	.017
Bran ....do....	.0037	Beans ....do....	.0074
Corn ....do....	.02	Potatoes ....do....	.0025
Corn, rye, and oatmeal ....do....	.03	Cotton in seed ....do....	.0245
Flour, wheat ....do....	.004	wool ....do....	.0588
Wheat	Free.	Hides, green, all kinds ....do....	.02
Provisions:		Dry or salted ....do....	.034
Bacon, salted or pickled...per pound..	.03	Tobacco, leaf ....do....	.15
Hams, all kinds ....do....	.11	Wool, raw ....do....	.058
Beef, fresh or dried ....do....	.0147		

The treaty negotiated with this country makes the following concessions to agricultural products imported as the products of the United States:

Free of duty—Wheat and wheat flour, corn meal, rye, rye flour, barley, potatoes, beans, peas, hay, oats, pork salted, including pickled pork and bacon except hams, and cotton-seed oil.

At a reduction of 25 per cent—Lard and substitutes, bacon hams, butter and cheese, canned and preserved meats, fruits and vegetables.

Our export and import trade with this country for the fiscal year 1891 prior to the negotiation of the treaty is given. In the compilation the trade has been divided into agricultural and nonagricultural, and the principal items of agricultural imports and exports shown in detail.

EXPORTS.

Articles.	Value.	Articles.	Value.
Live animals:		Provisions—Continued.	
Horses	$3,600	Lard	$1,304,970
All other animals and fowls	429	Butter	20,841
		Cheese	388
Total	4,029	All other provisions	1,523
Breadstuffs:		Total	2,146,456
Bread and biscuit	9,796	Miscellaneous:	
Corn	8,451	Apples, green or ripe	6,555
Corn meal	92	Canned fruits	1,525
Wheat	501,207	Cotton-seed oil	20,102
Wheat flour	3,838,919	Tobacco leaf	4,807
All other breadstuffs	27,656	Beans } Peas }	3,354
Total	4,386,121	Potatoes	65
Provisions:		All other agricultural exports	85,919
Canned beef	3,142	Total agricultural exports	6,658,933
Salted beef	1,416	Total nonagricultural exports..	7,390,340
Tallow	6,275	Total exports	14,049,273
Bacon	801,785		
Hams	1,557		
Pickled pork	4,559		

IMPORTS.

Articles.	Value.	Articles.	Value.
FREE OF DUTY.		DUTIABLE.	
Agricultural products:		Live animals, including live poultry	$625
Live animals	$20	Fruits	
Cocoa, crude, and leaves and shells of	502,547	Provisions, comprising meat and dairy products	140
Coffee	62,022,022		10
Fruits, including nuts	282,847	Sugar and molasses	2,280,919
Hair, not elsewhere specified	178,544	Tobacco, leaf	2
Hides and skins, other than fur skins	2,515,344	Wool, raw	17,909
Sugar and molasses	2,860,204	All other agricultural products	995
All other agricultural imports	13,659	Total agricultural imports dutiable	2,300,600
Total agricultural imports free	68,375,187	Total nonagricultutal imports dutiable	42,551
Nonagricultural imports free	12,512,257	Total imports dutiable	2,343,151
Total imports free of duty	80,887,444	Total imports free	80,887,444
		Grand total of imports	83,230,595

A glance at this computation is sufficient to show the one-sided character of our trade with this country. While buying Brazilian products to the extent of $83,230,595, we sold to that country only $14,049,273. In other words, out of our total trade with that country our purchases constituted 86 per cent and our sales only 14 per cent. An adverse balance of trade is to be expected where our dealings are with a country which largely supplies the world with a staple article of consumption like coffee and which at the same time has neither the wealth nor the necessity for largely supplying itself with foreign products, but it is the duty of commercial and political wisdom to reduce the balance to as small a figure as possible.

An examination of the table in connection with the Brazilian customs tariff shows that our trade relations with that country have not been reciprocally fair, and the new treaty, that portion of which relating to agricultural products is presented above, shows what steps have been taken to correct the inequality. During 1891 we bought from Brazil agricultural products to the value of $70,675,787 and sold her but $6,658,933. Of our purchases, $68,375,187 was admitted into our ports free of all duty, and of the $2,000,000 dutiable all but $20,000 was represented by sugar, which is now free. Practically, therefore, only $20,000 of Brazilian products pay duty in our ports. At the same time we were charged heavy duties on almost every agricultural product we sold in the markets of that country. Our principal articles and the duty we paid were:

	Value.	Duty per pound.
		Cents.
Wheat flour	$3,838,919	0.4
Bacon	801,785	3.0
Lard	1,304,970	4.9

By the new treaty flour will go in free and there will be a reduction from the regular duty of 25 per cent in the case of lard and bacon.

CUBA AND PUERTO RICO.

The Cuban tariff, corrected up to April 27, 1885, is presented. There should be added to the rates given below 25 per cent war duty and an

increase of 20 per cent. There is also a wharf duty of $1 per 1,000 kilograms (2,204 pounds) gross weight.

Article.	Duty.	Article.	Duty.
Live animals:		Provisions—Continued.	
Animals for breeding	Free.	Butter, including weight of earthen or glass package ....per cwt..	$4.767
Horses more than 63 inches high..each..	$67.135	Cheese, Spanish, Holland, and similar sorts ....per cwt..	3.633
Horses less than 63 inches high..do...	26.854	British, Swiss, Italian, and similar sorts ....per cwt..	7.939
Mules more than 58½ inches high..do...	32.225	United States and similar sorts ....per cwt..	2.625
Mules less than 58½ inches high..do...	9.445	Eggs ....do....	2,625
Cattle ....do...	3.334	Poultry ....per pound..	.03
Sheep, goats, etc ....do...	.889	Lard ....per cwt..	3.07
Hogs ....per cwt..	2.185	Apples and other fruit, including weight of package when in glass jars ....per cwt..	1.05
Breadstuffs:		Rice:	
Corn, rye, oats, and peanuts ....do....	.441	Clean ....do....	.819
Flour of rye and corn ....do....	.441	In hull ....do....	.399
Flour of wheat, including weight of package ....per cwt..	1.97	Hides:	
Provisions:		Common, dried ....do....	2.625
Bacon, salt pork, and dried meat..do....	2.625	Green ....do....	.882
Superior meats, as mutton, smoked tongue, etc ....per cwt..	6.342	Sheep and goat skins ....do....	6.573
Pickled beef, including weight of pickle ....per cwt..	.756	Cotton:	
Pickled pork, including weight of pickle ....per cwt..	1.26	Raw ....do....	2.520
Sausage, stuffed meats, in lard and cans ....per cwt..	6.30	Hemp and flax:	
Canned meats, including weight of cans ....per cwt..	10.584	Raw ....do....	1.05
Fresh meats ....do....	.609		

The tariff rates for Puerto Rico, given below, were increased 20 per cent July 1, 1890:

Articles.	Duty.	Articles.	Duty.
Live animals:		Provisions—Continued.	
Horses, mules, and asses ....each..	$4.63	Butter ....per cwt..	.168
Cattle ....do...	3.70	Cheese ....per pound..	.025
Swine ....do...	1.667	Lard ....per cwt..	1.478
Sheep and goats ....do...	.555	Cotton:	
Breadstuffs:		Raw ....do....	2.10
Cereals ....per cwt..	.336	Hemp and flax:	
Flour of wheat ....do....	1.025	Raw ....do....	.672
Flour of corn and other grains..do....	.273	Grease ....do....	1.68
Provisions:		Rice:	
Pork and bacon ....do....	1.176	Hulled ....do....	.756
Salt and jerked meats, salt or in brine ....per cwt..	1.092	Tobacco:	
		Leaf ....per pound..	.147
		Wool ....per cwt..	5.510

The arrangement with Spain relative to the trade of Cuba and Puerto Rico provides that from September 1, 1891, to June 30, 1892, as a provisional measure, a number of our products shall be admitted free and others at greatly reduced rates. The treaty further provides that after July 1, 1892, the regulations shall be as follows:

Free of duty—Cotton, cotton seed, oil and meal cake of cotton; tallow and other animal greases unmanufactured; meats in brine salted and smoked, including bacon, hams, meats preserved in cans, in lard, or by extraction of air, jerked beef excepted; lard and butter; cheese, oats, rye, barley, and flour of these cereals; maizena and other corn products, except corn meal; fruits; fresh, dried, and preserved, except raisins; vegetables, and garden products, hay, straw for forage, bran, trees, plants, shrubs, and garden seeds.

Specific duties per 100 kilograms (220.4 pounds)—Corn and corn meal, 25 cents; wheat, 30 cents; wheat flour, $1.00.

Reduction of 50 per cent—Preserved alimentary substances and canned goods not otherwise provided for, including sausages, stuffed meats, sauces, pickles, jams and jellies, and rice, hulled or unhulled.

Our trade with Cuba and Puerto Rico during 1891 is presented, showing in detail the principal items making up the aggregate imports and exports of agricultural products.

AGRICULTURAL EXPORTS.

Articles.	Value.	Articles.	Value.
Live animals:		Provisions—Continued.	
Horses	$32,245	Pickled pork	$259,626
Mules	7,935	Lard	2,317,226
Cattle	570	Butter	30,761
All other animals and fowls	2,427	Cheese	45,601
Total	43,177	All other provisions	67,996
Breadstuffs:		Total	3,424,339
Bread and biscuit	45,736	Miscellaneous:	
Corn	225,567	Apples, green or ripe	3,943
Corn meal	29,008	Canned fruits	11,692
Wheat	23	Cotton-seed oil	555
Wheat flour	1,260,714	Tobacco, leaf	1,590
All other breadstuffs	62,806	Beans Peas	128,287
Total	1,623,854	Potatoes	170,699
Provisions:		All other agricultural exports	115,726
Canned beef	891	Total agricultural exports	5,523,862
Salted beef	6,598	Total nonagricultural exports	8,518,077
Tallow	3,026		
Bacon	430,539	Total exports	14,041,939
Hams	262,075		

AGRICULTURAL IMPORTS.

Articles.	Value.	Articles.	Value.
FREE OF DUTY.		DUTIABLE.	
Agricultural products:		Live animals	$1,581
Live animals	$6,459	Fruits, including nuts	84,569
Cocoa, crude, and leaves and shells of	669	Provisions, comprising meat and dairy products	10,735
Coffee	41,628	Sugar and molasses	25,233,408
Fruits, including nuts	1,652,452	Leaf tobacco	7,141,465
Hair, not elsewhere specified	3,004	All other agricultural products	118,894
Hides and skins, other than fur skins	354,683		
Sugar and molasses	24,657,693	Total agricultural imports dutiable	32,590,652
All other agricultural imports	60,116	Total nonagricultural imports dutiable	4,386,396
Total agricultural imports free	26,776,704	Total imports dutiable	36,977,048
Nonagricultural imports free	1,124,753	Total imports free	27,901,457
Total imports free of duty	27,901,457	Grand total of imports	64,873,505

In our trade with Cuba and Puerto Rico in agricultural products we collected last year, outside of sugar, now free, duties on only $7,357,244 worth of products, while giving a free market to products to the value of, including all sugar, $52,010,112. Tobacco from Cuba was the only product of importance paying any duty. Practically we furnished a free market for the staple products of these countries. At the same time we paid duties on almost every item we sold in their markets.

Lard was the principal item exported, and in Cuba it paid a duty of $3.07 per hundredweight; flour paid $1.97 per hundredweight; bacon, $2.63 per hundredweight; pickled pork, $1.26 per hundredweight, and other products were burdened with similar heavy duties, in some cases intended to be prohibitory.

The following statement, in connection with the table of our exports, will show the duty we have paid in Cuba and the advantage we secure under the new treaty:

	Old duty.	Duty under treaty.
Wheat flour ....per cwt..	$1.97	$0.50
Bacon and hams ....do.....	2.625	Free.
Lard ....do.....	3.07	Free.
Pickled pork ....do.....	1.26	Free.

These four items, in spite of the heavy duties shown above, constituted 82 per cent of our exports of farm products to Cuba and Puerto Rico. With the exception of flour, which bears but a nominal rate, they are free under the new arrangement, and this country will undoubtedly monopolize the trade in these and other similar products.

DOMINICAN REPUBLIC.

The treaty with the Dominican Republic provides that the following articles shall be admitted free:

Animals, live; meats of all kinds, salted or in brine, but not smoked; corn or maize, corn meal and starch, oats, rye, and barley, and buckwheat, and flour of these cereals; hay, bran, and straw for forage; trees, plants, vines, seeds, and grains of all kinds for propagation; cotton-seed oil and oil-cake meal, tallow in cake or melted.

The following articles will be admitted at a reduction of 25 per cent from the regular duty:

Meats not otherwise provided for, and all meat products—excepting lard—butter, cheese, condensed or canned milk, fruits and vegetables fresh, canned, dried, pickled, or preserved.

Our trade with Santo Domingo for 1891 is presented.

AGRICULTURAL EXPORTS.

Article.	Value.	Article.	Value.
Live animals:		Provisions—Continued.	
Horses	$1,150	Pickled pork	$7,411
Mules		Lard	53,879
Cattle		Butter	21,130
All other animals and fowls		Cheese	7,130
		All other provisions	2,131
Total	1,150		
		Total	147,460
Breadstuffs:			
Bread and biscuit	3,979	Miscellaneous:	
Corn	64	Apples, green or ripe	377
Corn meal	2,088	Canned fruits	1,108
Wheat		Cotton-seed oil	840
Wheat flour	206,239	Tobacco, leaf	16
All other breadstuffs	9,631	Beans, Peas	2,550
Total	222,001	Potatoes	4,521
		All other agricultural exports	23,505
Provisions:			
Canned beef	174	Total agricultural exports	403,528
Salted beef	1,885	Total nonagricultural exports	583,298
Tallow	41,756		
Bacon	2,147	Total exports	986,826
Hams	9,817		

AGRICULTURAL IMPORTS.

Articles.	Value.	Articles.	Value.
FREE OF DUTY.		DUTIABLE.	
Agricultural products:		Sugar	$593, 168
Cocoa, crude, and leaves and stems of	$2, 002	Total agricultural imports dutiable	593, 168
Coffee	51, 972	Total nonagricultural imports dutiable	7, 502
Fruits, including nuts	3, 752	Total imports dutiable	600, 670
Hides and skins, other than fur skins	95, 503	Total imports free	1, 009, 690
Sugar	689, 463	Grand total of imports	1, 610, 360
All other agricultural products	....		
Total agricultural imports free	842, 692		
Total nonagricultural imports free	166, 998		
Total imports free of duty	1, 009, 690		

Our trade with the Dominican Republic amounted in 1891 to about $2,600,000, nearly two-thirds of which was made up of imports, and almost one-half of imports of sugar. Wheat flour, tallow, lard, and butter made up the principal items of our agricultural exports, and on them all there was a heavy duty. With the exception of sugar, which is now free, not a single agricultural product imported from that country paid duty in our ports. We furnished a free market for everything, but in return were taxed on nearly everything we sold. The reciprocal arrangement entered into corrects this manifest unfairness. All kinds of salt meats, not smoked, will go free, as will tallow and a number of other products, while smoked meats, butter, and other items of considerable value will be admitted at a reduction of 25 per cent from the regular duty.

SAN SALVADOR.

The treaty negotiated with the Republic of Salvador provides that the following articles shall be admitted free of duties of any kind:

Animals for breeding purposes, corn, rice, barley, and rye, beans, hay and straw for forage, fresh fruits, and hops.

Our foreign trade with San Salvador in 1891 is shown.

AGRICULTURAL EXPORTS.

Articles.	Value.	Articles.	Value.
Live animals:		Provisions—Continued.	
Horses	$2, 950	Pickled pork	....
Mules	....	Lard	$794
Cattle	900	Butter	202
All other animals and fowls	185	Cheese	305
Total	4, 035	All other provisions	747
		Total	3, 502
Breadstuffs:		Miscellaneous:	
Bread and biscuit	373	Apples, green or ripe	794
Corn	20, 696	Canned fruits	7, 864
Corn meal	....	Cotton-seed oil	1, 169
Wheat	83	Tobacco, leaf	274
Wheat flour	273, 162	Beans	....
All other breadstuffs	3, 919	Peas	....
Total	298, 233	Potatoes	3, 572
		All other agricultural exports	31, 801
Provisions:		Total agricultural exports	351, 244
Canned beef	68	Total nonagricultural exports	783, 751
Salted beef	....	Total exports	1, 134, 995
Tallow	832		
Bacon	....		
Hams	554		

AGRICULTURAL IMPORTS.

Articles.	Value.	Articles.	Value.
FREE OF DUTY.		DUTIABLE.	
Agricultural products:		Sugar	$49,844
Coffee	$1,670,869	Total agricultural imports dutiable	49,844
Hides and skins, other than fur skins	13,988	Total imports dutiable	49,844
All other agricultural products	25,104	Total imports free	1,733,222
Total agricultural imports free	1,709,961	Grand total of imports	1,783,066
Total nonagricultural imports free	23,261		
Total imports free of duty	1,733,222		

Our imports from San Salvador are made up almost entirely of two items, coffee and sugar. Agricultural exports are mainly breadstuffs. Coffee has been free of duty in this country since 1872, and hence the only concession Salvador receives is in the free admission of the small amount of sugar sent us. In return we are given a free market for animals for breeding purposes, a portion of the cereals, forage, fruits, and hops.

BRITISH GUIANA, ETC.

The treaty with the United Kingdom relative to the trade with British Guiana, Trinidad, and Tobago, Barbadoes, Leeward Islands, and Windward Islands, excepting the island of Granada, provides that the following articles shall be admitted free of duty:

Animals, including only asses, sheep, goats, hogs, poultry, and horses for breeding; beef, including tongues, smoked and dried; beef and pork preserved in cans; bones and horns; bran, middlings, and shorts; cotton seed and its products; eggs; fruits and vegetables, fresh and dried, when not canned, tinned, or bottled; hay and straw for forage; starch of Indian corn; trees, plants, vines, and seeds, and grains of all kinds for cultivation.

The following articles will be admitted at a reduction of 50 per cent from the customs tariffs now in force:

Bacon and bacon hams, bread and biscuit, cheese, lard and its compounds, and mules.

The following articles will be admitted at a reduction of 25 per cent from the tariffs now in force:

Beef, salted or pickled; corn, corn meal, wheat flour; pork, salted or pickled; wheat.

In the case of wheat flour it is stipulated that the 25 per cent provision shall not apply in Trinidad, but that it shall not bear a duty to exceed 75 cents per barrel.

AGRICULTURAL EXPORTS.

Articles.	Value.	Articles.	Value.
Live animals:		Provisions—Continued.	
Horses	$300	Pickled pork	$157, 857
Mules	24, 170	Lard	26, 582
Cattle	....	Butter	17, 833
All other animals and fowls	12, 321	Cheese	27, 385
		All other provisions	27, 962
Total	36, 791	Total	360, 069
Breadstuffs:		Miscellaneous:	
Bread and biscuit	14, 802	Apples, green or ripe	3, 494
Corn	30, 382	Canned fruits	1, 195
Corn meal	24, 361	Cotton-seed oil	10, 122
Wheat	....	Tobacco, leaf	42, 996
Wheat flour	704, 264	Beans } Peas }	20, 584
All other breadstuffs	10, 930	Potatoes	1, 530
Total	784, 739	All other agricultural exports	36, 590
Provisions:		Total agricultural exports	1, 298, 110
Canned beef	1, 772	Total nonagricultural exports	463, 240
Salted beef	67, 282	Total exports	1, 761, 350
Tallow	13, 236		
Bacon	10, 924		
Hams	9, 236		

AGRICULTURAL IMPORTS.

Articles.	Value.	Articles.	Value.
FREE OF DUTY.		DUTIABLE.	
Agricultural products:		Fruits, including nuts	$25
Live animals	$10	Sugar	3, 892, 602
Cocoa, crude, and leaves and shells of	197	Total agricultural imports dutiable	3, 892, 627
Fruits, including nuts	200	Total nonagricultural imports dutiable	12, 920
Sugar	973, 470	Total imports dutiable	3, 905, 547
Total agricultural imports free	973, 877	Total imports free	977, 659
Total nonagricultural imports free	3, 782	Grand total of imports	4, 883, 206
Total imports free of duty	977, 659		

In 1891 our agricultural imports from British Guiana amounted to $4,866,504, and, with the exception of sugar, only $25 of this paid any duty to our Government. A free market was furnished for all products sold us. Our exports of farm products amounted to $1,298,110, and we paid duties on nearly everything. This inequality in trade relations is corrected by the arrangement entered into for this and other English colonies. Our principal items of export for 1891, with the reciprocity provisions regarding them, are shown:

	Value.	Per cent off regular duties.
Flour	$704, 264	25
Pickled pork	157, 857	25
Salted beef	67, 282	25
Bacon and hams	20, 160	50
Cheese	27, 962	50
Lard	26, 582	50

These concessions showed result in reducing the balance of trade heretofore so strongly against us.

COURSE OF COMMERCIAL PRICES.

Markets and items.	Unit of measure.	1891. January 2.	1891. April 1.	1891. July 1.	1891. October 1.	1892. January 2.
Portland, Me.:						
Corn	Bushel	$0.69 –$0.70	$0.87 –$0.88	$0.73 –$0.74	$0.80 –$0.81	$0.69 –$0.70
Oats	...do	.56 – .57	.65 – .68	.57 – .59	.45 – .46	.47 – .49
Potatoes	...do	.90 – 1.00	.90 – 1.00	1.10 – 1.20	.45 – .60	.45 – .50
Hay, loose	Ton	12.00 –14.00	12.00 –14.00	12.00 –14.00	10.00 –12.00	10.00 –12.00
Butter, creamery	Pound	.25 – .28	.23 – .25	.25 – .28	.25 – .28	.28 – .32
Cheese, sage	...do	.12½– .13½	.13 – .14	.11½– .12½	.11½– .12½	.13¾– .14½
Eggs	Dozen	.29 – .30	.16 – .18	.18 – .19	.20 – .22	.27 – .30
Lard, keg	Pound	.07 – .10½	.07 – .10½	.07½– .10½	.07½– .10½	.07 –
Wool, fleece, washed	...do	.25 – .35	.25 – .35	.25 – .35	.25 – .35	.25 – .27
Boston, Mass.:						
Corn, No. 2 mixed	Bushel	.64½	.83	.68	.67 – .68	.54
Oats, No. 2 white	...do	.55½	.63 – .63½	.48	.37 – .37½	.41 – .41½
Rye	...do	.78 – .80	1.00	.95 – .97	1.00	.95
Barley, 2-rowed State	...do	.85 – .88	.85 – .88	....	....	.70 – .75
Potatoes, Houlton Hebrons	...do	1.05 – 1.08	1.15 – 1.20	....	.45	.50
Hay, fair to good	Ton	13.00 –14.00	12.00 –12.50	14.00 –15.00	15.00 –16.00	16.00 –17.00
Butter, extra dairy	Pound	.24 – .25	.25 – .26	.18 – .19	.23 – .24	.27 – .28
Cheese, Vermont, extra	...do	.09¾– .10	.11¾– .12	.08	.09½– .10	.11¼– .11½
Eggs, Eastern extras	Dozen	.28	.22	.18	.22	.27
Lard, city rendered	Pound	.06½– .06⅝	.07¼	.06¾– .07	.07¾– .08	.06¾– .07
New York, N. Y.:						
Wheat, No. 2 winter	Bushel	1.04¾– 1.05⅛	1.17 – 1.18	1.03⅞– 1.04⅝	1.03⅛– 1.04¼	1.06⅜– 1.07⅛
Corn, No. 2 mixed	...do	.61¾	.80	.69	.61⅞– .62	.53¼– .53½
Oats, No. 2 mixed	...do	.49⅜– .49½	.59	.39 – .40	.33 – .33¼	.39¼– .39½
Rye, State	...do	.78 – .80	.96	.85 – .90	.93 – .95	1.00 – 1.02
Barley, 2-rowed State,	...do	.83 – .85	.80	....	....	.64 – .65
Pork, prime mess	Barrel	11.50 –12.00	13.00 –13.50	11.50 –12.00	11.50 –12.00	9.00 –10.00
Butter, State dairy	Pound	.23 – .25	.28	.18	.22½– .23	.24 – .25
Cheese, State factory	...do	.09¾	....	.08⅜– .08⅝	.09⅝– .09¾	.11¼– .11½
Eggs	Dozen	....	....	.17½– .18	.22	.27
Hay	100 lbs	.55 – .65	.60 – .70	.95 – 1.00	.80 – .90	.85 – .90
Tobacco, Connecticut leaf	Pound	.11 – .23	.11 – .23	.11 – .23	.16 – .30	.16 – .30
Tobacco, Virginia wrapper	...do	.10 – .23	.10 – .23	.10 – .23	.15 – .25	.15 – .25
Philadelphia, Pa.:						
Wheat, winter	Bushel	1.04	1.10	1.05	1.01½	1.00½
Corn, No. 2 mixed	...do	.60	.78½	.68½	.66	.52
Oats, No. 2 white	...do	.50½	.60½	.45	.36	.41
Hay, timothy	Ton	10.50	11.00	13.50	14.50	14.50
Baltimore, Md.:						
Wheat, No. 2 red winter	Bushel	.96	1.10¼	1.00½	1.02	1.02¼
Corn, mixed	...do	.57½	.73¾	.65	.64½	.52½
Oats, No. 2 white	...do	.50	.62 – .62½	.42	.36 – .37	.40
Rye, No. 2	...do	.80	.97 – .98	.75	.93 – .94	.94½– .95
Hay, timothy	Ton	9.50 –11.00	10.00 –10.50	11.50 –12.00	12.50 –13.50	12.50 –13.50
Wool, tub-washed, fair to choice	Pound	.32 – .35	.32 – .35	.30 – .33	.30 – .33	.32 – .33
Atlanta, Ga.:						
Corn, white	Bushel	.75	.90	.83	.82	.58
Oats, No. 2 mixed	...do	.59	.67	.56	.44	.46
Potatoes	Barrel	3.75	4.50	4.00 – 5.00	2.25 – 2.50	2.00
Hay	Cwt	.90	.95	.85	.95	.95
Beef, dressed	Pound	.06	.05½	.06 – .07	.08¾	.05¾
Cotton	...do	.08⅓	.08¼	.07½	.08½	.07
Eggs	Dozen	.26	.13	.13	.19 – .21	.25
New Orleans, La.:						
Corn, No. 2 white	Bushel	.64	.83	.80	.68 – .69	.56
Oats, No. 2	...do	.54	.62	.51 – .52	.37½	.42
Hay, prime	Ton	14.00 –15.50	15.50 –16.00	17.00 –18.00	13.50 –15.00	15.00 –16.00
Pork	Barrel	9.75	13.50	11.50 –12.00	12.00 –12.25	9.50
Cincinnati, Ohio:						
Wheat, No. 2 red, winter	Bushel	.96 – .97	1.06½– 1.07	.98 – 1.00	.97 – .97½	.95 – .96
Corn, No. 2 mixed	...do	.52½	.73 – .73½	.60 – .61	.57	.43
Oats, No. 2 mixed	...do	.43½– .44	.57½– .58	.41 – .41½	.30½– .31¼	.34¼– .34¾
Rye, No. 2	...do	.73½– .74	.92	.85	.88	.92 – .93
Potatoes	...do	.95 – 1.00	1.15 – 1.25	....	.35 – .40	.30 – .35
Hay, timothy	Ton	9.00 – 9.50	10.00 –10.50	10.00 –11.00	9.50 –10.00	11.00 –11.50
Pork, mess	Barrel	10.00 –10.12½	12.37½–12.50	10.50 –10.62½	10.50	8.50 – 8.75
Butter, fancy creamery	Pound	.30 – .31	.30 – .31	.19 – .20	.26	.30
Cheese, Ohio factory	...do	.09 – .09½	.11 – .11½	.07 – .08	.09 – .09½	.11 – .11½
Eggs	Dozen	.20	.15	.13 – .13½	.17	.18

COURSE OF COMMERCIAL PRICES—Continued.

Markets and items.	Unit of measure.	1891. January 2.	1891. April 1.	1891. July 1.	1891. October 1.	1892. January 2.
Chicago, Ill.:						
Wheat, No. 2 red, winter	Bushel..	$0.88½–$0.89¾	$1.05	$0.92 –$0.93	$0.95 –$0.95¼	$0.90
Corn, No. 2	....do ...	.48¾– .49½	$0.67½– .67⅝	.58¼– .59	.52½– .53¼	.37¼–$0.39⅛
Oats, No. 2	....do ...	.42 – .42½	.54 – .54⅛	.33¼– .33½	.26¾– .27	.30 – .30¼
Rye, No. 2	....do ...	....	.86 – .86½	.72 – .76	.83 – .83½	.86¾– .87
Hay, No. 1 timothy	Ton.....	9.00 – 9.75	14.00 –15.00	13.00 –14.00	10.50 –11.00	12.50 –13.50
Beef, extra mess	Barrel ..	5.50 – 5.75	6.75 – 7.00	8.25 – 8.50	6.00 – 6.50	5.50 – 5.75
Pork, mess	....do ...	10.20 –10.25	12.50 –12.62½	10.00 –10.12½	9.87½–10.00	10.37½–10.50
Eggs	Dozen ..	.22	.16 – .16½	.14½– .15	.18 – .18½	.23 – .24
Milwaukee, Wis.:						
Wheat, No. 2 spring	Bushel..	.83¾	.99⅜	.87¼– .88¼	.89	.84½
Corn, No. 3	....do ...	.47½– .48½	.70	.57½	.53½	.37
Oats, No. 2 white	....do ...	.42 – .43	.55 – .55½	.39	.30½– .31¼	.32¼– .32½
Barley, No. 2	....do ...	.66½	.72	.68½	.60½	.57
Rye, No. 1	....do ...	.67	.88	.79	.84 – .84¼	.86½
Potatoes	....do ...	.75 – 1.00	.90 – 1.10	.50 – .80	.25 – .35	.20 – .35
Hay, timothy	Ton.....	8.00 – 8.50	12.50 –13.00	14.50 –15.50	12.00 –12.50	13.50 –14.50
Pork, mess	Barrel ..	10.25	12.45	10.10	9.85	7.75
Beef, extra mess	....do ...	6.25	7.50	8.50	6.50	6.25
Butter, creamery	Pound ..	.23 – .25	.25 – .26	.15 – .16	.23 – .25	.24 – .26
Cheese, Wisconsin	....do ...	.09½– .10½	.09 – .14	.07¾– .12	.09 – .11½	.10 – .12
Wool, washed	....do ...	.25 – .26	.25 – .26	.22 – .24	.23 – .24	.24 – .25
St. Louis, Mo:						
Wheat, No, 2 red, winter	Bushel..	0.92¾– 0.93¾	1.04 – 1.04½	0.87¼– 0.89	0.93¾– 0.93⅞	0.90½– 0.90⅝
Corn, No. 2	...do	.47 – .48	.64½– .65	.55 – .55½	.53	.36⅛– .36½
Oats, No. 2	...do	.42⅜–	.53½– .53⅝	.34 – .34½	.27¼– .27½	.31 – .31½
Rye, No. 2	...do	.62½– .63	.88 – .90	.85	.81	.82
Potatoes, choice	...do	.95 – 1.10	1.00 – 1.05	.70 – .80	.38 – .40	.30
Hay, timothy	Ton.....	12.00 –13.00	15.50 –16.50	16.00	12.00	13.00
Beef, family	Barrel ..	....	6.50	10.50	9.50	7.50
Pork, mess	...do	10.37½–10.50	12.25 –12.50	10.50	10.75	10.50
Lard, prime steam	Pound ..	.05½– .05⅝	.06½– .06⅝	.05$\frac{85}{100}$	.06$\frac{65}{100}$	.05¾
Eggs	Dozen ..	.18½	.14½	.11½	.16½	.18½
Tobacco, Missouri burley	100 lbs..	5.00 – 6.50	5.00 – 6.50	5.00 – 7.00	5.00 – 7.00	5.50 – 6.50
Wool, tub-washed, fair	Pound ..	.30 – .32	.30 – .32	.26 – .27	.28 – .30	.28 – .30
San Francisco, Cal.:						
Wheat, No. 1, white	Cental ..	1.35	1.53¾– 1.55	1.52½	1.67½– 1.68¾	1.80 – 1.81¼
Barley, No. 2, brewing	...do	1.52½– 1.55	1.42½– 1.42¾	1.55	1.11¼– 1.13¾	1.12½– 1.15
Oats, No. 2	...do	1.82½– 1.85	1.70¼– 1.70½	1.60	1.32½– 1.33¾	1.30 – 1.32½
Corn, No. 1, white	...do	1.32½– 1.35	1.40 – 1.42½	2.20	1.37½– 1.40	1.35 – 1.37½
Rye, No. 1	...do	1.32½– 1.35	1.32½	1.30	1.60 – 1.62½	1.67½– 1.70
Potatoes	...do	.90 – 1.15	.70 – 1.00	.50 – .75	.35 – .60	.30 – .65
Hay, No. 1, oats	Ton.....	13.00 –14.50	14.00 –16.00	11.00 –12.00	11.00 –12.00	13.50 –14.50
Butter, good to choice	Pound ..	.32½– .36	.19 – .20	.19½– .21	.25 – .30	.32 – .33½
Cheese	...do	.11 – .13	.11 – .12½	.09 – .09½	.11 – .12	.12 – .15
Eggs, choice	Dozen ..	.30 – .32½	.18 – .22	.20 – .23	.32½– .35	.40 – .42½
Wool, Oregon Valley	Pound ..	.20 – .22	....	....	.19 – .21	....

TRANSPORTATION RATES.

In compliance with requirement of Congress, there have been published in each monthly crop report during the past year statements showing the rates of freight upon agricultural products, via rail and water, from the more important points of shipment to large market centers in all parts of the country. These reports have also contained tabular statements showing the cost of transportation to foreign countries. The rates published were those in effect upon the first day of each month.

The rates between New York and Chicago have been remarkably steady throughout the year. No changes were reported in West-bound rates, and only one in East-bound. On the 1st of May the returns showed an advance of 2 cents per 100 pounds upon cattle in carload lots, or from 26 to 28 cents, with the usual differences to other Eastern markets.

The returns from companies doing business between Missouri River

points and Chicago show that the rates in that territory were also very uniform during the year. Only one change is reported in the rates from Kansas City, Atchison, or St. Joseph to Chicago, which was an increase, November 1, of 3 cents per 100 pounds upon live hogs in carload lots. From Omaha to Chicago no change was reported during the year. From these Missouri River points to St. Louis the rates remained the same throughout the year, with the exception of those upon live stock. January 1 the rates upon cattle, sheep, and hogs were $14\frac{3}{4}$, $17\frac{1}{2}$, and 15 cents per 100 pounds, respectively; May 1 they were advanced to 20, $21\frac{1}{2}$, and $18\frac{1}{2}$ cents; September 1 reduced to the January 1 rates, and November 1 they were increased to 20, $21\frac{1}{2}$, and $21\frac{1}{2}$ cents.

The average rates for the year were higher than they were for 1890. The average upon corn and wheat, Chicago to New York, shows the advance. The average rate on corn for 1890 was about $11\frac{1}{3}$ cents per bushel, while for 1891 it was about 15 cents. The rate on wheat for 1890 was about $14\frac{1}{3}$ cents, and for 1891 about 15 cents. These figures show an increase of $3\frac{2}{3}$ cents on corn, and two-thirds of a cent on wheat.

The following statement shows the all-rail rate from Chicago to New York from 1870 to 1891:

Years.	Chicago to New York.			
	Corn per bushel.		Wheat per bushel.	
	Average rate.	Per cent of decrease.	Average rate.	Per cent of decrease.
	Cents.		Cents.	
1870	28.00	....	30.00	....
1871	29.68	*6.0	31.80	*6.0
1872	32.66	*16.6	34.99	*16.6
1873	28.93	*3.3	31.02	*3.4
1874	24.50	12.5	26.25	12.5
1875	22.40	20.0	24.00	20.0
1876	15.74	43.8	16.86	43.8
1877	18.90	32.5	20.50	31.7
1878	16.52	41.0	17.70	41.0
1879	14.56	48.0	17.74	40.9
1880	17.48	37.6	19.80	34.0
1881	13.40	52.1	14.40	52.0
1882	13.50	51.8	14.47	51.8
1883	15.12	46.0	16.20	46.0
1884	12.32	56.0	13.20	56.0
1885	12.32	56.0	13.20	56.0
1886	14.00	50.0	15.00	50.0
1887	14.70	47.5	15.75	47.5
1888	13.54	51.6	14.50	51.7
1889	12.82	54.2	15.00	50.0
1890	†11.31	59.6	†14.37	52.1
1891	†15.00	46.4	†15.00	50.0

* Increase. † Straight average.

TRANSATLANTIC RATES.

The average cost for transporting our surplus farm products to foreign countries for the year 1891 was much higher than for 1890. During the first six months of the year 1890 the rates were rather high, and the average rate upon wheat and corn from New York to Liverpool was nearly 8 cents per bushel, while the average rate for the last half of the year was only about $4\frac{1}{4}$ cents. For 1891 the situation was reversed, the average for the first half of the year being about $4\frac{4}{5}$ cents and for the last half about $8\frac{4}{5}$ cents. The average rate for the year 1890 was nearly 6 cents and for 1891 nearly 7 cents.

The following statement shows the average monthly cost for transporting several of the most important articles of export from New York

to Liverpool for the two years 1890 and 1891, as compiled from the returns of the leading steamship companies:

Articles.	January.		February.		March.		April.	
	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.
Wheat .... per bushel..	$0.11	$0.06	$0.11	$0.07	$0.10	$0.04	$0.07	$0.04
Corn .... do......	.11	.06	.11	.07	.10	.04	.07	.04
Flour .... per barrel..	.72	.48	.72	.54	.72	.36	.60	.36
Bacon .... per 2,240 pounds..	7.80	4.80	8.40	6.00	7.20	4.80	7.20	3.60
Lard .... do......	7.80	4.80	8.40	5.40	6.60	4.20	5.40	3.00
Beef .... per tierce..	1.44	.96	1.44	.96	1.32	.72	1.08	.60
Pork .... per barrel..	.96	.60	.96	.72	.84	.48	.84	.42
Cotton .... per pound..	$.00\frac{7}{16}$	$.00\frac{5}{16}$	$.00\frac{1}{2}$	$.00\frac{11}{32}$	$.00\frac{7}{16}$	$.00\frac{1}{4}$	$.00\frac{5}{16}$	$.00\frac{1}{4}$
Apples .... per barrel..	.72	.48	.72	.60	.72	.60	.72	.60
Butter .... per 2,240 pounds..	9.60	7.20	10.80	8.40	9.60	7.20	8.40	6.00

Articles.	May.		June.		July.		August.	
	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.
Wheat .... per bushel..	$0.04	$0.04	$0.04	$0.04	$0.05	$0.05	$0.05½	$0.06
Corn .... do......	.04	.04	.04	.04	.05	.05	.05½	.06
Flour .... per barrel..	.36	.36	.36	.36	.36	.36	.36	.36
Bacon .... per 2,240 pounds..	3.60	2.40	3.00	2.40	3.60	3.60	3.00	3.60
Lard .... do......	3.00	2.40	3.00	2.40	3.60	3.00	3.00	3.60
Beef .... per tierce..	.60	.42	.48	.48	.60	.60	.48	.60
Pork .... per barrel..	.48	.30	.36	.30	.48	.42	.36	.42
Cotton .... per pound..	$.00\frac{3}{16}$	$.00\frac{3}{16}$	$.00\frac{3}{16}$	$.00\frac{3}{16}$	$.00\frac{3}{16}$	$.00\frac{3}{16}$	$.00\frac{3}{16}$	$.00\frac{3}{16}$
Apples .... per barrel..	.72	.60	.48	.60	.60	.60	.72	.60
Butter .... per 2,240 pounds..	7.20	6.00	7.20	7.20	8.40	7.20	6.00	8.40

Articles.	September.		October.		November.		December.	
	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.
Wheat .... per bushel..	$0.03	$0.08	$0.03	$0.10	$0.03	$0.12	$0.06	$0.12
Corn .... do......	.03	.08	.03	.10	.03	.12	.06	.12
Flour .... per barrel..	.24	.48	.24	.60	.36	.72	.48	.72
Bacon .... per 2,240 pounds..	2.40	4.80	2.40	6.00	2.40	7.20	4.80	8.40
Lard .... do......	2.40	4.80	2.40	6.00	2.40	7.20	4.20	8.40
Beef .... per tierce..	.48	.84	.48	.96	.48	1.32	.72	1.44
Pork .... per barrel..	.36	.60	.25	.72	.36	.96	.48	.96
Cotton .... per pound..	$.00\frac{1}{2}$	$.00\frac{3}{8}$	$.00\frac{5}{16}$	$.00\frac{7}{16}$	$.00\frac{1}{4}$	$.00\frac{7}{16}$	$.00\frac{1}{4}$	$.00\frac{7}{16}$
Apples .... per barrel..	.60	.60	.60	.60	.48	.72	.48	.72
Butter .... per 2,240 pounds..	7.20	8.40	7.20	8.40	6.00	10.80	7.20	10.80

Although the foregoing statement shows that the rates have increased during the past year, still they are much lower than they were a few years ago. The average rate upon wheat for this year, New York to Liverpool, is about 6.84 cents per bushel, or about one-third the rate for 1873, which was 21.12 cents. It is only 43.8 per cent of the average rate for the decade 1870 to 1879, which was 15.61 cents. For the next decade, 1880 to 1889, the average rate was 7.65 cents, of which this year's rate is 89.4 per cent.

The following statement shows the yearly average rate upon wheat per bushel from New York to Liverpool for the years 1866 to 1891, inclusive:

Years.	Steamer rates.		Years.	Steamer rates.	
	Pence.	*Cents.*		*Pence.*	*Cents.*
1866	4.74	9.48	1879	6.20	12.40
1867	5.18	10.36	1880	5.88	11.76
1868	7.18	14.36	1881	4.08	8.16
1869	6.40	12.98	1882	3.87	7.74
1870	5.78	11.56	1883	4.54	9.08
1871	8.16	16.32	1884	3.40	6.80
1872	7.64	15.28	1885	3.60	7.20
1873	10.56	21.12	1886	3.46	6.92
1874	9.08	18.16	1887	2.71	5.42
1875	8.07	16.14	1888	2.67	5.34
1876	8.02	16.04	1889	4.06	8.12
1877	6.93	13.86	1890	*2.96	*5.92
1878	7.61	15.22	1891	*3.42	*6.84

* Straight average.

THE ERIE CANAL.

All things considered, the past season of navigation via this great water route, Buffalo to New York, must have been one of activity and prosperity. The season was longer by one day than that of 1890, and for the period the rates were higher. During the first half of the season, or from May 5 to August 15, the rates were lower than for the same time during the previous season, but from that date to the close of navigation, the time when the two great crops, wheat and corn, were being moved from the West to the seaboard, they were considerably higher. The same may be said of the lake rates, Chicago to Buffalo. The first half of the season the rates were low, while during the latter half they were comparatively high.

The following statement shows the weekly range of the rates upon wheat and corn, Chicago to Buffalo via lake, Buffalo to New York via Erie Canal, and the through rates, Chicago to New York, less the transfer charges at Buffalo:

[In cents per bushel.]

Week ending—		Lake—Chicago to Buffalo.						Erie Canal—Buffalo to New York.						Lake and canal—Chicago to New York.					
		1889.		1890.		1891.		1889.		1890.		1891.		1889.		1890.		1891.	
		Wheat.	Corn.	Wheat.	Corn.	Wheat.	Corn.	Wheat.	Corn.	Wheat.	Corn.	Wheat.	Corn.	Wheat.	Corn.	Wheat.	Corn.	Wheat.	Corn.
May	10	2¼	2	1¾	1½	1⅜	1⅛	4	3⅝	4	3⅝	2¾	2¼	6¼	5⅝	5¾	5⅛	4⅛	3⅜
	17	2¼	2	1¾	1½	1¼	1⅛	4	3⅝	4	3⅝	2½	1⅞	6¼	5⅝	5¾	5⅛	3¾	3
	24	2	1¾	1½	1¼	1	1	4	3⅝	4	3⅝	2½	2	6	5⅜	5½	4⅞	3½	3
	31	2¼	2	1½	1¼	1	1	4	3⅝	3¾	3⅜	3¼	2¾	6¼	5⅝	5¼	4⅝	4¼	3¾
June	7	2¼	2	....	....	1	1	4	3⅝	....	....	3	2½	6¼	5⅝	....	....	4	3½
	15	2¼	2	....	....	1	1	3¾	3⅜	....	....	3	2½	6	5⅜	....	....	4	3½
	22	2	1¾	....	....	1	1	3¾	3⅜	....	....	2⅞	2¾	5¾	5⅛	....	....	3⅞	3¾
	30	2	1¾	....	....	1½	1¼	3¾	3⅜	....	....	2¾	2⅜	5¾	5⅛	....	....	4¼	3⅝
July	7	2	1¾	2½	2⅛	1½	1⅜	3¾	3⅜	3⅝	3⅛	2¾	2⅜	5¾	5⅛	6⅛	5¼	4¼	3¾
	14	2¼	2	2¼	2	2	1¾	3¾	3⅜	3⅝	3⅛	2½	2¼	6	5⅜	5⅞	5⅛	4½	4
	22	2¼	2	2¼	2	2	1⅞	3¾	3⅜	3⅝	5⅛	2½	2¼	6	5⅜	5⅞	5⅛	4½	4⅛
	29	2	1¾	2⅛	1⅞	2¼	2¼	4	3⅝	3⅝	3⅛	3½	3¼	6	5⅜	5¾	5	5¾	5½
August	7	2¼	2	1½	1¼	3¼	3	4	3⅝	3¾	3¼	3¾	3⅜	6¼	5⅝	5¼	4½	7	6⅜
	15	2½	2¼	1½	1¼	2¾	2¼	4	3⅝	4	3½	3⅞	3⅜	6½	5⅞	5½	4¾	6⅝	5⅝
	23	2¾	2½	1½	1¼	2¾	2½	4	3⅝	4	3½	4	3⅝	6¾	6⅛	5½	4¾	6¾	6⅛
	30	3	2¾	1½	1¼	2½	2¼	4½	4	4	3½	4	3⅝	7½	6¾	5½	4¾	6½	5⅞
September	7	2⅞	2⅝	1¾	1¾	3¼	3	4½	4	4	3½	4	3½	7⅜	6⅝	5¾	4⅞	7¼	6½
	15	2⅞	2⅝	2	1¾	3½	3¼	5	4½	3⅞	3⅜	4¼	3⅞	7⅞	7⅛	5⅞	5⅛	7¾	7⅛
	22	2⅞	2⅝	2	1¾	3¾	3½	5	4½	3⅞	3⅜	4	3⅝	7⅞	7⅛	5⅞	5⅛	7¾	7⅛
	29	3	2¾	2	1¾	3	2¾	5	4½	3⅞	3⅜	4½	4⅛	8	7¼	5⅞	5⅛	7½	6⅞
October	7	3	2¾	2¼	2	2	1¾	5	4½	3¾	3¼	4½	4⅛	8	7¼	6	5¼	6½	5⅞
	14	3	2¾	2⅛	1⅞	2	1¾	5	4½	3¾	3¼	4⅜	4	8	7¼	5⅞	5⅛	6⅜	5¾
	22	3	2¾	1½	1¼	2	1¾	5	4½	4¼	3¾	4¾	4¼	8	7¼	5¾	5	6¾	6
	29	3⅛	2⅞	1¾	1½	2½	2¼	5	4½	4¼	3¾	4½	4	8⅛	7⅜	6	5¼	7	6¼
November	7	3	2½	1¾	1½	4	3¾	5	4½	4¼	3¾	4¼	3¾	8	7	6	5¼	8¼	7½
	15	2	1¾	2	1¾	4	3¾	5	4⅜	3½	3	3¾	3½	7	6⅛	5½	4¾	7¾	7¼
	22	2½	2¼	1¾	1½	4	4	5	4⅜	3	2½	4	3½	7½	6⅝	4¾	4	8	7½
	30	....	....	3½	3¼	4½	4¼	....	....	....	....	4¼	3¾	....	....	....	....	8¾	8

REPORT OF THE BOTANIST.

SIR: I have the pleasure of presenting herewith a report of the work of this division for the year 1891. It contains a statement of the results of the grass and forage experiments, and an account of the office and herbarium work, together with a short paper on the vegetation of the desert region of the Southwest, and an account of some new and injurious weeds.

Respectfully,

GEO. VASEY,
Botanist.

HON. J. M. RUSK,
Secretary.

FIELD WORK.

The past year has been one of unusual activity in the work of this division. A number of field agents have been employed in different parts of the country in an investigation of its vegetation, in order that the herbarium may be supplied with specimens and a more complete knowledge of the productions and resources of the country be obtained. The collection of specimens has been made in such quantities as to enable us to aid the agricultural colleges in the formation of their herbariums. The principal agents have been in Texas, Arizona, and adjacent parts of Mexico, Indian Territory, Minnesota, and Florida. From these agents we have received about 50,000 specimens.

An expedition was organized in January by the Division of Economic Ornithology and Mammalogy, in connection with the Division of Botany, for an exploration of the Death Valley of southern California, for the purpose of investigating the productions and resources of that remarkable region and the adjacent mountain ranges, and to mark the floral and faunal limits. This division was represented in the expedition by Mr. F. V. Coville as botanist, assisted by Mr. Frederick Funston. The field work continued until the 1st of September. The botanical report of the work of the expedition will be published later in the Contributions from the National Herbarium.

The herbarium of the Department has been further enlarged by exchange and by purchase of specimens from the following countries:

	Specimens.
From Canada	1,000
From Mexico	287
From Central America	268
From South America	420
From New Zealand	450
From India	1,310
From Africa	107

From our duplicates we have distributed about 6,000 specimens among thirty-one agricultural colleges and experiment stations. Nine thousand specimens have been mounted and added to the herbarium.

PUBLICATIONS.

Bulletin No. 12. Grasses of the Southwest: Plates and Descriptions of the Grasses of the Desert Region of Western Texas, New Mexico, Arizona, and southern California. By Dr. George Vasey. Part 2. Issued Oct., 1891. Roy. 8°, pp.7+[50], 50 plates.

Contributions from the U. S. National Herbarium. List of plants collected by Dr. Edward Palmer in 1890 in Lower California and western Mexico, at La Paz, San Pedro Martir, Raza Island, Santa Rosalia, Santa Agueda and Guaymas. By Drs. George Vasey and J. N. Rose. Vol. I. No. 3. Issued Nov. 1, 1890. 8°, pp. III+63-90. Index.

This paper is a report on 173 species collected at the above localities, including the collector's notes with remarks on new and rare species.

Contributions from the U. S. National Herbarium. List of plants collected by Dr. Edward Palmer in 1890 in western Mexico and Arizona. By J. N. Rose. Vol. I. No. 4. Issued June 30, 1891. 8°, pp, III + 91-127. 10 plates. Index.

In this paper 475 plants are enumerated with remarks as to soil, locality, size, and additional notes in case of rare or little known species, and with descriptions of new species.

Contributions from the National Herbarium. Manual of the Phanerogams and Pteridophytes of western Texas. By Dr. J. M. Coulter. Vol. II. No. 1. Issued June 27, 1891. 8°, pp. IV+152. Index.

This contribution is Part I of a manual for western Texas, and includes the Polypetalæ. It begins with an analytical key to the orders, followed by similar keys to the families. The number of genera enumerated and described is 270 and of species 761.

Bulletin No. 14. Ilex cassine: The aboriginal North American Tea. By Dr. E. M. Hale. Issued Nov., 1891. 8°, pp. 22, 1 plate.

This is a report upon the history, distribution, and use among the North American Indians of *Ilex cassine.*

GRASS AND FORAGE EXPERIMENT STATION AT GARDEN CITY, KANS.

By Dr. J. A. SEWALL, *Superintendent.*

An account of this station was given in the Report of the Secretary of Agriculture for 1890. The following is a report of operations for the year 1891, the third year of the experiments.

The area under cultivation at this station for the season of 1891 is about 220 acres, divided as follows:

ANNUAL CROPS.

	Acres.
Winter rye	40
Jerusalem corn	50
Poland wheat	10
Algerian wheat	2
Algerian barley	1
Ten varieties of corn	10
Sorghum (20 varieties nonsaccharine)	30
Broom corn	5

Of the above, the rye, wheat, barley, and sorghums were cultivated for the double purpose of determining their value as a crop without irrigation, and for the purpose of putting the newly broken ground into condition to sow grass seeds.

The yield was about as follows:

	Bushels.
Jerusalem corn	2,000
Polish wheat	240
Winter rye	500
Algerian barley	14
Red Kaffir corn	75

The sorghums are not harvested at this date, but the yield of each of the varieties will be above the average. The broom corn did fairly well, yielding about 1½ tons of excellent broom. (It will be proper here to state that the Jerusalem corn, the Kaffir corn, and broom corn are all varieties of *Sorghum vulgare.*) The 10 acres of alfalfa yielded two cuttings, and is in a promising condition for the future, although further trial is necessary before its permanency can be considered as established.

From the result of experiments for three seasons I believe that the "red Kaffir corn" is in every way superior to any of the varieties tested for fodder, as it furnishes more and better fodder than any other kind tried. The Jerusalem corn is of great value for its large and abundant yield of seed, which is as valuable as Indian corn for fattening hogs and cattle, and is also a fair food for human kind.

All the crops, especially the rye, wheat, and barley, suffered from the effect of the early drought. The rainfall from January 1, 1891, to May 21, 1891, was only 1.41 inches. From May 21 to October 3, 1891, the rainfall was 23.20 inches, or nearly 3 inches more than the average.

PERENNIAL CROPS.

	Acres.
Panicum virgatum, or switch-grass, a native grass for meadows	20
Agropyrum glaucum, or Colorado blue-stem, a native grass	10
Bromus inermis, a European pasture grass	6
Andropogon provincialis, or tall blue-joint, a native grass	5
Andropogon Hallii (Colorado sand-grass), a native grass	2
Andropogon scoparius, or broom-grass, a native grass	1
Avena elatior, or *Arrhenatherum avenaceum,* a European meadow-grass	5
Festuca elatior (tall meadow fescue), a European meadow-grass	2
Lolium perenne (perennial rye grass), a European meadow-grass	5
Festuca ovina (sheep's fescue), a European meadow-grass	½
Agropyrum tenerum, a native grass	1
Muhlenbergia glomerata, a native grass	¼
Alfalfa, or *Lucerne,* a fodder-plant	10
Sainfoin (*Onobrychis sativa*), a European fodder-plant	1

In addition to the above, small areas ranging from 1 to 20 rods were sown with a variety of grasses and forage plants, among which are: *Vetches* (2 varieties), *Anthyllis vulneraria, Galega officinalis* (a French forage plant); *Trifolium hybridum* (Alsike clover), *Trifolium incarnatum* (French or crimson clover), and *Trifolium stoloniferum.* These were greatly injured by grasshoppers in July, consequently no seeds were secured, but they have nearly recovered since.

From experiments conducted here during the past three years, I am satisfied that the following-named crops will succeed on the so-called arid or subarid plains, even in the driest seasons: Jerusalem corn, with proper cultivation, will yield from 40 to 50 bushels of seed per acre; red Kaffir corn will yield from 5 to 7 tons of excellent fodder per acre, superior to alfalfa as food for horses; *Panicum virgatum,* a native grass, sometimes called switch-grass, will yield from 1½ to 2 tons of hay per acre, superior to alfalfa as food for horses; *Bromus inermis* will yield from one-half to 3 tons per acre (2 cuttings), and is equal or superior to timothy for cattle or horses.

Of the four above-named plants I can speak with great confidence. Many others do well and give hopeful promise, but further trial is necessary before they can be placed in the "certain" list.

By direction of the Assistant Secretary of Agriculture, I planted as a wind-break and shelter belt four rows of trees (3,000) around a quarter section of the experiment grounds, viz, one row of cottonwood, two of black locust, and one of Russian mulberry. Owing to the early drought before mentioned, one-third failed to grow, but the balance, after the rains in June, made a vigorous growth. The black locust proved to be decidedly superior, not more than 5 per cent dying.

Over 8,000 applications for seeds have been made at this office (Garden City) the last season, nearly all being for Jerusalem corn and *Bromus inermis*. We were not able to fill more than one-third of these orders, but with the crops now on hand we hope to fill all reasonable applications.

With reference to the experiments as a whole, I know that with fair culture in this region, without irrigation, any person can raise every year a paying crop of winter rye, and during the driest year a good crop of Jerusalem corn, ordinarily a fair, and with a reasonable amount of rainfall a large, crop of Polish wheat, and above all a meadow and pasture of good productive and hardy grasses, one of which, called *Bromus inermis*, or brome-grass, is one of the best grasses in existence. This is a European grass recently brought into cultivation here. Nine-tenths of the corn was destroyed by the ravages of the corn worm. Reports on the Polish wheat distributed last winter state a yield of from 20 to 60 bushels per acre, without irrigation. There have been large crops of Jerusalem corn from the seed distributed last winter. The rainfall at this station up to October 3 has been 24.61 inches, while the average for the past fifteen years has been 20.27 inches.

COÖPERATIVE STATIONS IN THE WEST AND SOUTHWEST.

Arrangements for coöperative experiments in grasses and forage plants were made with the following Western experiment stations, viz, Texas, New Mexico, Arizona, Colorado, North and South Dakota, Utah, and Wyoming. In most of these stations the experiments are yet in an incipient stage, and the results have not been reported in detail. Prof. Dice McLaren, of the Wyoming Experiment Station, briefly states as follows:

All of the twenty grasses selected by you for the 1891 experiments germinated and appeared above the ground. The following were almost completely killed by the June drought: *Poa nemoralis, Dactylis glomerata, Panicum virgatum, Aira cæspitosa, Trifolium incarnatum,* and *Melilotus alba.*

The following have a very thin stand: *Trifolium hybridum, Hedysarum coronarium, Galega officinalis,* and *Poterium sanguisorba.*

The following are a success on plowed ground, and are given in the order of their excellence: *Medicago sativa, Lolium perenne, Festuca elatior, Bromus Schraderi, Bromus inermis, Phalaris arundinacea, Anthyllis vulneraria,* and *Onobrychis sativa.*

The *Panicum miliaceum* and the Jerusalem corn grow about 8 inches high, with good stand, but the frosts of August and September checked all further growth.

COÖPERATIVE BRANCH STATIONS IN THE SOUTH.

By S. M. Tracy.

In 1888 a branch station for special work with grasses and forage plants was established at the Mississippi Experiment Station, and in March, 1891, additional branches were established in connection with

the State experiment stations of North Carolina, Georgia, Florida, and Louisiana, all of which have been placed under the general supervision of S. M. Tracy, the director of the Mississippi Station. The work at the four stations last named has been in progress for such a short time that it is now too early to state results, though excellent progress has been made and these stations are now in fine condition. The results of work with some of the more common species at the Mississippi Station are given in the Report of the Department of Agriculture for 1889, and these, with but little modification, fairly represent the work of the present season. As one of the principal objects of the work at this station was the testing of the newer and less known sorts, special pains were taken to procure seeds of such native species as seemed to promise future value, and also of such foreign species as had proved valuable in their native countries. Quite a number of species from the arid regions in the Southwest, several local species, and a large number from Australia, India, Russia, and other foreign countries, are now under cultivation tests. Of most of these only very small amounts of seed could be procured, and the areas grown were necessarily small, but seeds from the plats of the more promising sorts were saved, so that larger areas have now been planted, and seeds have been sent to several of the other stations. During the present year 367 species have been planted, and although many of them, as was to be expected, have proved to be of little value for this locality, there are a number of them which appear so well suited to the climatic and soil conditions of the Gulf States that their areas are being increased as rapidly as is possible. The work with many of these species has now been continued through three seasons, and on sufficient areas to give strong indications of their permanent value. A description of the more important of these follows.

COLORADO BLUE-STEM (*Agropyrum glaucum*).—Of the six Western species of *Agropyrum* which have been tested here this is decidedly the best, though it has not grown so vigorously and satisfactorily as it does on the Western plains. It bears drought well, and makes one cutting of inferior hay, but its principal value here will be as a part of a mixture for a permanent pasture. From the excellent growth which this grass is making at the Garden City Station and at places in New Mexico and Texas we had hoped that it might be of value here, but so far we have seen little to recommend it for the Gulf States.

JAPANESE RYE (*Agropyrum Japonicum*).—In its general habit this is much like fescue-grass (*Bromus Schraderi*), but does not grow as large and the heads are somewhat bearded. It will grow later in the season, however, and propagates itself more readily from seeds on unplowed land, and is perennial. It is eaten readily by all kinds of stock, and appears to be a valuable species for mixing with other pasture grasses.

AUSTRALIAN BLUE-GRASS (*Andropogon erianthoides*).—This is a perennial species from Australia which has been cultivated in a few localities for a number of years and advertised to a considerable extent, but its growth has not been very satisfactory here. It is so tender that it barely lives through the winter in this latitude, and starts into growth very late in the spring, though it makes an excellent growth during the summer, and will give two fair cuttings of fine, tender, and nutritious hay. The leaves are killed by a moderate frost, and it fails to hold the ground against the encroachments of other grasses. Several other species of *Andropogon* from Australia and from India have also been tested, but this appears to be the best of the

genus and the only foreign one which makes any promise of final success.

Smooth Brome (*Bromus inermis*).—This is also nearly related to the fescue-grass, but endures the summer heat and drought much better and will grow on a much harder and poorer soil. It produces a great amount of long and tender leaves near the ground, while the culms are rather slender and are not produced in very great abundance, so that it is better fitted for grazing than for hay. It is one of the few species which remains green through the entire year and bears grazing well. One plat of this was sown three years ago and, so far, it has held the ground to the complete exclusion of all other grasses and weeds.

Star-grass (*Chloris Swartziana*).—This is a perennial species which is found growing wild near the coast from Florida to Texas, and which has grown remarkably well in cultivation in central Mississippi. It propagates readily from seed, and sends out runners from 1 to 2 feet in length, from each joint of which a cluster of long, tender, and succulent leaves is produced. It bears frost well, and the leaves grown in October and November remain green and fresh until February, thus making it an excellent winter pasture. It does not bear tramping as well as do some others, and does not grow sufficiently tall for hay, but there are very few species which will yield as much good pasture as will this during December and January.

Indian Beard-grass (*Chrysopogon serrulatus*).—This is a perennial grass, the seed of which was received from India, and which is one of our most valuable importations. Although nearly related to our native "broom-sedge," it starts into growth much earlier in the spring, produces a heavier growth of leaves, and will yield two cuttings of excellent hay, besides a considerable amount of winter pasturage. It has been entirely free from any injury from cold and from all attacks of fungous diseases, and is spreading well by self-sown seeds. It grows from 4 to 5 feet high, and more than one-half the weight of the hay is made up of the leaves, the stalks being rather small. We have saved all the seeds we could collect of this species, and have distributed them to the other stations for further trial.

Crested Dogstail (*Cynosurus cristatus*).—This grass has been very highly recommended in Europe and in the northern States, but it has been of no value here. Although it has been sown at six different times, and on a variety of soils, during the last three years, and has never failed to germinate, we have found only two plants which matured seeds, and all the plants from every sowing have now disappeared, having been killed by very moderate droughts.

African Millet (*Eleusine coracana*).—The seed of this grass was procured from France, where it is highly recommended as a "quick crop." It was sown here in 1888 for the first time, when it grew finely and matured a heavier crop of seed than did any other grass. It grew about 2 feet high, with very large, flattened, tender, and succulent stems, which are well covered with leaves. The seeds are produced in heads similar to those of the common "crowfoot" grass, but are very large, usually about one-tenth of an inch in diameter, and single heads sometimes weigh over 2 ounces. It matures by the end of May, and, as it is an annual, the ground can then be used for other purposes. It does not bear pasturing well, and the seed grown here does not seem to produce as vigorous plants as were grown from that which was imported. It grows more rapidly and ripens earlier than does the common millet, but seems to possess no other advantage and makes a smaller yield.

Teff (*Eragrostis Abyssinica*).—This is one of the several species of

"love-grass" which have been received from India and Australia, and which has been very highly recommended for both hay and pasture, especially in India. Here, it has grown about 2 feet high the first season, making one good cutting and a second lighter one of excellent hay. It is an annual, and the seed grown here seems to be lacking in vigor, the growth of the second and third years being too small to make the species desirable for general cultivation.

SLENDER LOVE-GRASS (*Eragrostis parviflora*).—This is from the same countries and appears much better suited to our climate, growing fully 3 feet high, with very slender culms and an abundance of leaves. Although an annual, it reseeds the land freely, makes excellent hay, and is one of the best of the genus for this locality.

EVERLASTING GRASS (*Eriochloa annulata*).—This is a perennial in Australia, its native country, but here it barely survives the winter, and a large part of its spring growth comes from seed which were scattered on the ground during the previous season. It starts very early in the spring and grows rapidly, reaching about 2 feet in height, and producing a large number of slender culms, which are well covered with leaves, and an abundant supply of seeds. It can be cut at least three times, bears pasturing well, and makes excellent hay. Mr. Turner, botanist of the Australian department of agriculture, says this is "a superior pasture grass, found in the coastal districts and in the colder parts of the colony. It will grow and furnish feed nearly all the year round in the coastal districts, but during early summer months it yields a great amount of rich, succulent herbage, greedily devoured by stock of all kinds. This grass is worth the attention of dairy farmers."

TEOSINTE (*Euchlæna luxurians*).—Although this has been before the public for many years, it has not yet attained the popularity which it deserves in the Southern States. It is a remarkably vigorous grower, reaching 10 or 12 feet in height, with an unusually abundant supply of leaves and very slender stems, which continue to grow until killed by frost. If cut when it reaches 4 or 5 feet in height it makes excellent hay, and will produce a second crop fully as large. If left to grow until September or October it furnishes the very best of material for the silo, and a greater amount per acre, than does either corn or sorghum, and we have found no other plant which is its equal for soiling purposes. Its season of growth is so long that it seldom matures seed north of latitude 30°, but it ripened well last year at the Louisiana Station.

VELVET GRASS (*Holcus lanatus*).—This has been in cultivation here for many years, but has never been as satisfactory as it appears to be in some other localities. When young it is very easily killed by drought, and in wet seasons it suffers severely from the attacks of a rust (*Puccinia coronata*), which is frequently so abundant as to kill the plants when they are about ready to bloom. When the grass becomes well established, and escapes the rust, it is fairly permanent on very dry and barren soils, affording a considerable amount of good grazing or a moderate cutting of hay early in the summer, but on rich soils it is soon crowded out by other species and, in this region, can be recommended only for mixing with other grasses for pasture lands.

MANY-FLOWERED MILLET (*Oryzopsis membranacea*).—This is a perennial species from the Western plains which makes a vigorous growth, producing leaves 2 feet or more in length and culms 3 feet in height. The leaves, however, are quite tough and wiry, and the stems very hard and woody, so that it would be regarded as being practically worthless were it not for its ability to withstand the most severe droughts, and

the fact that it remains green through the winter. It possesses these two characteristics to an unusual degree, however, and we shall plant it more largely in the future.

MUNRO GRASS (*Panicum agrostoides*).—This grass has been in cultivation to some extent for fifteen years, and is valued highly wherever it is known. It requires a rich soil, on which it grows 3 or 4 feet high, produces an unusual amount of leaves, has tender and succulent stems, and bears drought well. Two crops of good, though rather coarse, hay can be cut during the summer, after which it should be allowed to mature seed. It is of but little value for winter pasture, but for hay and for summer and fall grazing it is the best of the genus. It grows spontaneously in all of the Southern States, usually being found along creek banks and on the borders of ponds, and seed can be saved with very little trouble.

PARÁ GRASS (*Panicum barbinode*).—This is a perennial species which produces runners from 10 to 30 feet in length, with an abundant supply of leaves and upright branches, and yielding an immense amount of forage. It does not mature seed in this latitude, but the roots live through the winter, and the new growth is ready to cut by June 1, and will yield a good cutting once in six weeks from that time until the end of the season, though it should not be cut after October 1, in order that it may have time to produce a crop of leaves to serve as a winter protection for the roots. This is of considerable value for the region near the coast, but is too tender to be recommended for localities subject to severe frosts. *Panicum spectabile*, from southern Europe, is very similar, but is rather coarser, and does not appear to be relished as well by stock, though it bears more cold.

INDIAN MILLET (*Panicum frumentaceum*).—In India this is cultivated largely for its starchy seeds, which are used for food, but it has not succeeded well here. On rich soil it makes a small crop of hay early in the season, but makes no second growth, and must be seeded annually like the German millet. If sown late, the seed does not mature before hot weather causes it to blight, and on poor soil it seldom reaches over a foot in height. It is in every way inferior to the German millet.

SWAMP PANIC (*Panicum gibbum*).—This is one of the many native species of *Panicum*, and is found wild from Carolina to Florida and Texas. It usually grows in swampy soils, where it often reaches a height of 6 feet, but will also grow well on uplands, and spreads rapidly by seeds and by runners. It starts with the first warm days of spring and continues its growth, even in severe droughts, until killed by heavy frosts. It produces more seed than does any other native *Panicum*, and, as the seed is produced continuously throughout the season, it is of unusual value for both hay and pasture. At this time, October 15, when clover and orchard grass are both nearly dead from a drought of two months, this is green and flourishing.

SPREADING PANIC (*Panicum proliferum*).—While this grass prefers a damp soil, it will also grow well on dry uplands, and as it makes its best growth in late summer when other species have been killed by drought, it is well worth cultivating. It continues to grow until killed by frost, and, while rather coarse for hay, it makes excellent pasture, and cattle prefer it to almost any other grass during its season. When pastured too closely stock will prevent the maturing of seed, but with moderate grazing it will reseed itself freely.

TEXAS MILLET (*Panicum Texanum*).—This is much like the swamp panic, but larger and coarser in every way, and although an annual, it

reseeds itself freely and holds the ground well against other grasses and weeds. Mr. Lea, of Texas, says:

I consider it far superior to any grass that I ever saw for hay. It is a much more certain crop than millet, and cultivated with less labor, and all kinds of stock prefer it. In this region it is regarded, in the condition of well-cured hay, as more nutritious than any other grass. It grows only in cultivated ground; it prospers best in the warmest season of the year; its luxurious growth subdues other grasses and some weeds.

With us it has not covered the ground as closely as has the swamp panic, and the stems are rather coarse for the best quality of hay. It also starts later in the spring, but bears drought equally well, and makes a heavier growth late in the season.

BLUE CANARY-GRASS (*Phalaris cœrulescens*).—A perennial European species which, in manner of growth and quantity of hay, is much like timothy, but is far better suited to the Southern climate. Here it is usually ready to cut about June 1, the culms being then from 4 to 5 feet high and well covered with fresh leaves. The yield of hay is very heavy and of the best quality, but no second crop is produced. It bears grazing much better than does timothy, but its chief value lies in its hay-producing qualities. As it matures at the same time as does red clover, it will be of value for sowing with it, as timothy is used in the Northern States. Most of our seed has been imported from France, and we have had difficulty it making it germinate, but the American-grown seed has done much better in that respect.

SORGHUMS (*Sorghum vulgare* vars.).—A large number of varieties of sorghum have been grown, the best of which appears to be the "Kaffir branching" variety. This has grown about 12 feet in height, and is similar to the common sorghum, but produces a much heavier yield of seed, and so is of more value for forage. It branches very freely from the upper joints, single stalks often bearing as many as fifteen heads of seed. If cut early it will have fewer heads, but has more green leaves, and the stalk is less dry and pithy than if cut late. This has been the best of the cultivated varieties, though the "rural branching" and the "yellow branching" have done nearly as well. The two latter varieties are almost identical, and both are valuable, especially for soiling purposes, as they make a rank second growth after cutting, even late in the season. Neither grows more than 6 or 7 feet high, and both have stalks which are large and coarse, but are unusually well covered with leaves. While they are superior to the "Kaffir" sorghum for soiling, their total yield of both seed and forage is less.

There is a variety of sorghum commonly known as "chicken corn" which has become thoroughly naturalized in a few counties of eastern Mississippi and western Alabama, and which is a valuable addition to our hay-producing crop. In general appearance this sorghum is much like the ordinary broom corn, though the heads are less spreading, and the stalks usually branch at several of the upper joints, so that each bears a number of heads. It is usually most abundant in cornfields, where it starts into growth late in the summer, after the crop has been laid by, but grows rapidly and in September the corn in many fields is entirely hidden and the field appears as though planted with the common sorghum. If cut before heading it makes excellent hay and, on rich land, will produce a heavy second crop. If allowed to mature, the yield of seed is about the same per acre as is that of the ordinary cultivated varieties and is worth about as much for stock feed. The seed can be gathered at an expense of 10 cents per bushel, and many planters now make a business of saving it to use in the place of corn, though

it is somewhat difficult to keep on account of the attacks of weevils. It has one serious fault, which is that it is unsafe to permit stock to feed upon it when making a rank second growth late in the season. At that time it is often fatal, and sometimes so within a few minutes. It seems to affect only certain animals, or perhaps only certain plants produce the ill effect, as generally only a few animals in a herd are killed, and these are commonly found very near together. The plant is said to have been noticed here first about twenty years ago, and it is doubtless descended from some of the many varieties of sorghum which were brought to this country from China. The area which it now occupies is probably not more than 200 miles in diameter, being confined mostly to the "black-prairie" region, but it is spreading slowly, and will doubtless soon be found in other localities also.

SACCATONE (*Sporobolus airoides*).—This is one of the perennial Western species, which is much like the "many-flowered millet" in producing an immense amount of slender, tough, wiry leaves, which endure the most protracted droughts without injury and remain fresh and green during the winter. It is worthless for hay, but is certainly a valuable addition to our pasture varieties.

BEGGAR-WEED (*Desmodium molle*).—This plant requires close attention to be of value, but when properly treated it has been one of our most profitable forage plants. The soil for it must be rich, and should be moist rather than dry; the ground must be well prepared, and planting postponed until there is no danger from heavy frosts. The plants grow rapidly and should be cut when not more than 2½ feet high, as, if allowed to grow taller, the lower leaves drop and the stalks become too coarse for hay. It will give at least three cuttings in a season, and, as the roots go very deep, it is a renovating rather than an exhausting crop. Cattle are very fond of it, but it bears grazing only moderately well and does not reseed itself well on uncultivated ground.

WINTER VETCH (*Lathyrus hirsutus*).—There are two distinct varieties of *Lathyrus*, both of which are known in this country as "hairy vetch," but as one of them makes its best growth during the cool months of winter and the other during the warmer months of summer, it seems better to adopt the French names of "winter" and "summer" vetch. The winter vetch is sown in September or October, so that it may germinate with the fall rains and secure a root-hold before very cold weather. It will grow slowly for a few weeks, but about the 1st of January the roots are sufficiently developed so that the tops begin to grow rapidly, and by February the plants form a dense mat from 1 to 2 feet deep, and continue to grow until hot weather. The plants bear grazing well, and stock of all kinds eat the dry hay greedily. For the Gulf States this is by far the most valuable of the many species which are sold under the general name of "vetch," making a heavier growth, being eaten more freely, and reseeding itself more fully.

BURR CLOVER (*Medicago macalata*).—This plant is well worth cultivating in all of the Gulf States, and is growing in favor with those who have tested its merits. It is essentially a winter grower, being at its best from February to May, after which it ripens its seed and soon disappears. Stock which are unaccustomed to its use do not always like it at first, but all soon learn to eat it, and many seem to prefer it to any other plant. It is an excellent plant for sowing on Bermuda land, as it matures its seed and dies at about the time the Bermuda starts into growth, and when the latter is killed by frost the clover soon takes its place. A mixture of these two plants comes nearer giv-

ing continuous pasture than does any other mixture which we have tested.

CRIMSON CLOVER (*Trifolium incarnatum*).—This has attracted great attention in the South during the past three or four years, but its true merits are still in doubt. So far it has not given a good crop at the Mississippi Station, though it is valued highly at the Carolina Station, and at the Florida Station has given one immense crop, followed by two failures. Under favorable circumstances it makes a very vigorous winter growth, and affords good grazing or soiling, but in many cases only a scattering stand is secured and the plants are weak and sickly. It can not be recommended for general use until more is known of the conditions necessary to its success.

CHARACTERISTIC VEGETATION OF THE DESERT REGION FROM WESTERN TEXAS TO CENTRAL ARIZONA.

By L. H. DEWEY, *Assistant Botanist.*

In June (1891) the writer spent about ten days in the country between Del Rio, Tex., and Phœnix, Ariz., traveling on the Southern Pacific Railroad, and stopping at El Paso, Tucson, and Maricopa. The following notes are based on observations made from the car windows, or while wandering about in search of plants at the places visited. The summer rains usually begin in the higher elevations near the last of June, so that the desert was seen at its driest time, at the end of the spring dry season.

The soil throughout the region was as dry as a hot sun and a dry wind could make it. But little water was found anywhere away from the rivers, and even these often had a dry and thirsty look. As there was very little moisture outside of the irrigated regions, the atmosphere was very dry and evaporation consequently rapid. These conditions of dry soil and rapid evaporation, with a change twice a year, especially in the higher altitudes, caused by heavy rains, explains many of the curious forms of vegetation.

The topography of the country is doubtless another important factor in determining the kinds of plants which have survived there. The entire region is broken by mountain ranges rising from 1,000 to 4,000 feet above the general level. Between these ranges the valleys are generally quite level, showing a noticeable absence of hills and hollows, which are so abundant in the glacial region. The soil varies from coarse crumbling granite to sand and clay. It is generally somewhat alkaline. I shall describe only the vegetation of the uncultivated and unwatered desert, for the irrigated tracts are by no means parts of the desert. Del Rio, Tex., was the first station visited west of the one hundredth meridian. The land here slopes gradually up from the bluffs along the river, the soil being mostly sandy. The woody plants most noticeable here are the mesquit, Parkinsonia, Ceanothus, and Rhus.

Mesquit (*Prosopis juliflora.*)

(Plate I.)

The mesquit (mĕs-kēt′), which is most abundant, is one of the characteristic shrubs throughout the entire desert, and even extends beyond its limits as far east as Austin. It varies in size from a straggling bush 2 feet high to a well-formed tree 50 feet high with a trunk 2 feet in diameter. Away from water it seldom becomes much of a tree. It is of

such slow growth that it is almost impossible to count the annual layers. The wood is very hard and brittle, and it is commonly said that it is easier to break it with the back of the ax than to cut it with the blade. It forms the chief wood supply of the region. In the streets of San Antonio it makes probably the finest wood pavement in the country. Near Phœnix I saw several cords of it piled up to run an engine at a gold mine. This wood was cut 3 feet long, and cost $3.75 per cord. Where the sand blows these mesquit bushes cause it to drift about them, often making mounds 4 or 5 feet high with a few twigs of the bushes still alive and projecting out at the top. Inside of these mounds there is a dense growth of roots and buried bushes. There is very little shrubby growth above ground in these regions of drifting sand, and the people mine in these mounds for fuel. The fruit of the mesquit or mesquit beans are prepared in various ways for food.

Parkinsonia Texana.

The Parkinsonia founa at Del Rio is a shrub about 2 feet high with abundant thorny green branches, looking like lilac sprouts with the outer barks peeled off. A few yellow flowers were to be found on the bushes in June, but the small leaves which the plant has during a few weeks of the rainy season were about all gone, and an entire bush could not cast shade enough to keep a lizard out of sunlight.

Ceanothus Fendleri.

A Ceanothus was found here, about a foot in height, that almost rivaled the Parkinsonia in illustrating the compactness of vegetation where evaporation is to be contended with. The stems of the Ceanothus were thickly crowded with spiny branchlets an inch long or less, and these in turn were pretty thickly crowded with nearly sessile round leaves scarcely three-eighths of an inch in diameter.

Rhus microphylla.

A bush less abundant than the others mentioned, but a little taller, is a species of sumach (*Rhus microphylla*). This bush has grayish bark and, as the name indicates, rather small leaves. It was quite attractive when I saw it, being well filled with small red berries, which are more pleasing to the sight than the taste. Very little grass was to be found on the dry land. There was nothing like a close green sod except in a few well-watered dooryards, where Bermuda grass had been introduced. Here and there was a little stool of Aristida, and there were scattered patches of withered grass showing that a Bouteloua (white grama-grass) had been quite plentiful in the rainy season. On the irrigated land I saw a pretty good crop of hay being cut. It was mostly brome-grass, called there Texas blue-joint (*Andropogon saccharoides*). Johnson grass (*Sorghum halapense*) flourishes on the irrigated lands to an extent that is quite vexatious to cultivators. From Del Rio to El Paso, along the Southern Pacific, the region is scarcely a part of the desert proper. The railroad winds about most of the way through a broad valley 3,000 to 5,000 feet above the sea level. The landscape in June had generally a gray appearance, due to a rather thin growth of an almost woody species of grass (*Hilaria Jamesii*). This is one of the Gietta grasses, although sometimes improperly called black grama. It grows in small bunches a foot high or less, and at first sight appears to be dead, but it is alive and waiting for the next rainy season to get

a drink to grow on. It is very nutritious, and furnishes a large part of the forage for the thin cattle that seek pasture here. Some of the true grama-grasses (*Boutelouas*) are found here also. The gray background is dotted here and there, often quite thickly, with the dark green of the yucca, or the lighter green of the prickly-pear cactus. Two forms of yucca are common in these high valleys. One has sharp-pointed stiff leaves, about 18 inches long, projecting out from the base, and a stalk 5 to 10 feet tall, bearing large spreading panicles of cream-colored flowers.

Spanish bayonet (*Yucca baccata*).

(Plate II.)

Two or three species of yucca are called Spanish bayonet. The most abundant form here has a thick stalk about 3 or 4 feet tall, bearing sharp-pointed leaves at its top which project in all directions. From the center of this leaf-cluster arises the flower-bearing stalk, seldom more than 3 feet long, and bearing a more compact cluster of creamy white flowers. These yuccas, as well as the cactus, owe their present existence in this region to the fact that their juicy edible parts are so well protected that even a Texan steer must starve before obtaining much nourishment from them. The cactus is fed to cattle after the spines have been removed by fire or otherwise.

El Paso, on the Rio Grande, is about 3,700 feet above sea level. The soil here varies from adobe clay near the river to solid rock up at the top of Mount Franklin, 3,000 feet above the river. The intermediate steps are coarse sand, gravel, and broken rock which bears no evidence of being waterworn by even an artificial shower. In the adobe soil are found a species of *Baccharis*, an almost shrubby composite; a small flowered aster (*Aster spinosus*), with smooth green stem, armed with sharp spines, but with few leaves, if any; a low-spreading *Sphæralcea*, with bright orange-colored flowers, and many other species less abundant. Vegetation is nowhere dense, however, except at the very edge of the muddy river or along the irrigating ditches. In the sandy soil back from the river there is a thin growth of bushes—mesquit, creosote, and acacia. These each make a thin straggling growth of about 2 or 3 feet out of the top of the little sand hills which surround them, and altogether cover perhaps one-twentieth of the ground, which is nearly barren of anything else. A few composites grow here, most noticeable among them the bright yellow-flowered *Riddelia arachnoidea* and *R. tagetina*.

Creosote bush (*Larrea Mexicana*).

(Plate III.)

The creosote bush is one of the most typical plants of the desert; for it is found throughout the desert and, unlike the mesquit, nowhere else, not even in the oases. It is a sticky, resinous bush, with small round evergreen leaves, yellow flowers, woolly fruit, and a very strong disagreeable odor, which is suggested by its name. It is reported to have valuable medicinal properties, and is used to some extent in the mining camps as a "cure all" for both man and beast.

Acacia bush (*Acacia constricta*).

(Plate IV.)

This is the most abundant acacia found here, but three or four others are not uncommon in the desert. They are mostly low spindling bushes,

of little if any value except to give a little touch of green to the landscape. They have small leaves and very small yellow flowers in dense spherical or cylindrical heads. The *Acacia constricta* is well distinguished by the slender pods, 3 or 4 inches long, constricted between the seeds.

Vine cactus or candlewood (*Fouquiera splendens*).

(Plate V.)

On the hillsides in the coarse gravel is found the vine cactus. This is not a cactus, but its appearance gives it its name. The plant consists of from one or two to half a dozen stalks about an inch in diameter, nearly straight, and about 5 feet tall. The stalks are gray in color, armed with abundant spines, and bearing comparatively few small green leaves. At the top of the stalks are one or more clusters of orange-colored flowers or fruits. These plants, as insignificant in appearance as the mullein stalks in the East, serve many useful purposes. Set up in line close together they make a living hedge that even a jack rabbit can not pass, and many yards and gardens are fenced in this manner. Set more closely in line around a rectangle 5 feet wide and 10 feet long, with an opening at one end and a covering of brush over the top, they make a complete house for a family of Mexicans of the poorest class.

Growing in the same locality as the *Fouquiera*, and still farther up in the rough broken rock, is an Agave (*Agave heteracantha*), bearing a beautiful spike of light-yellow flowers with long purple filaments and large yellow anthers. Several species of cactus are found in the rocky soil from the upper limit of the *Fouquiera* to the top of the mountain. These are mostly flattened or nearly spherical species of *Mammilaria* or *Cereus* from 1 to 6 inches in diameter. At the top of Mount Franklin a few small shrubs are growing in the crevices of the rocks, and also a rather rare grass (*Scleropogon karwinskianus*), which, together with an *Aristida*, furnishes a scanty pasture for goats. From the top of Mount Franklin one may see the country for miles around in all directions, and it looks pretty barren. No timber is to be seen anywhere. A strip of green marks the Rio Grande, but aside from this the general color is that of the yellow sand. The region of high valleys in southern New Mexico through which the "Sunset Route" passes from El Paso to Tucson is to a great extent very similar to that in Texas between Del Rio and El Paso. Some of the region in southeastern Arizona, however, is much broken with rocky and gravelly hills, resembling somewhat those back of El Paso. Here we find several species of century plants, one of the most prominent being *Agave Parryi*.

Amole (*Agave Parryi*).

(Plate VI.)

This has a cluster of thick spiny-margined leaves, from which arises a stem an inch or two in diameter and 8 to 12 feet tall, bearing at the top a showy panicle nearly a foot wide and three times as long, of creamy white flowers. Such plants in the Eastern cities would be worth a small fortune apiece. Here they grow wild and luxuriant and are almost unnoticed. At Tucson we have conditions and a vegetation similar to those of El Paso. There are a few Arizona additions, however. Several forms of cactus here were not seen in Texas,

Giant cactus (*Cereus giganteus*).

(Plate VII.)

This cactus grows here, but it is more abundant along the railroad farther west and along the branch from Maricopa to Phœnix. It is by far the largest form of vegetation in the desert. Specimens 12 to 18 inches in diameter and 20 to 40 feet tall are not very uncommon, and even larger ones may be seen. This peculiar plant usually consists of a coarsely ribbed, spiny, cylindrical column, tapering at the top and bottom, and bearing from one to half a dozen ascending branches. Every plant seen was scarred, often in many places, where thirsty travelers had cut holes in the rind to obtain the juice.

Another noticeable species of cactus (*Opuntia arborescens*) grows in a much branched and bush-like form and is thickly clothed with light-colored spines.

Palo-verde (*Parkinsonia Torreyana*).

(Plate VIII.)

This very peculiar naked evergreen tree, 20 feet high or more, is found here. It does have small green leaves in the rainy season, but these soon drop off and the smooth, light-green surface of the entire tree makes it appear as if stripped of bark as well as leaves. In the dry season very little grass is to be seen, except upon close examination. One little plant 2 or 3 inches high, which will be picked up for a grass and dropped more quickly for a thistle, is quite abundant in the sand. It is *Triodia pulchella*, a grass with short, rigid, sharp-pointed leaves and an almost sessile panicle of spikelets, which are white and woolly.

Gietta grass (*Hilaria rigida*) is another desert grass of more importance, for it aids materially in furnishing forage. It grows in clumps a foot or more in diameter, and is coarse and woody, but very nutritious. Its woody character prevents its being killed by too close cropping or by tramping, as is the case with the grama-grasses found here.

Sporobolus airoides and *Sporobolus Wrightii* aretwo very coarse perennial rush grasses, growing in bunches, and where there is some moisture in the soil.

Without irrigation there is apparently but little hope of success in agricultural pursuits in the desert except in grazing, and overfeeding is spoiling the ranges for that industry. With irrigation the agricultural possibilities are almost unlimited, as proved by the fruits, crops, and cattle raised in the Salt River Valley.

TWO WEEDS NEW TO THE UNITED STATES.

By J. N. ROSE, *Assistant Botanist.*

The attention of agriculturists is here called to the introduction of two plants which promise to be common pests. Both plants are spreading rapidly and are giving farmers much trouble wherever they have gained a foothold. While these weeds seem to have come to stay, yet nothing definite can be stated. Weeds are sometimes introduced, which spread rapidly for a few years, and then as rapidly disappear, and it is to be hoped that such may be the case with these.

The following descriptions will be of aid in identifying these two species:

ORDER OROBANCHACEÆ.

Branched Broom-rape (*Orobanche ramosa*).

(Plate IX.)

An annual plant, 6 to 15 inches high, with many slender branches of a brownish or straw color, more or less hairy, parasitic upon the roots of other plants. Small, colorless bracts, instead of leaves. Flowers scattered in long, slender branches; flower stalk very short; bracts three, one larger at the base of the flower stalk, two smaller at the base of the flower. Calyx 4-toothed, split on the back. Corolla light blue, 2-lipped; lower lip 3-lobed; upper-lip notched. Stamens 4. Style 1, with a broad 2-lobed stigma. Ovary 1-celled. Seeds minute, very numerous.

This plant is a native of Europe, and has only been known in the United States about five years; it is very rapidly spreading, and it is feared that it may prove a most injurious weed in this country. The attention of this Department was first called to this plant in 1889, and, from reports since received, it is rapidly spreading. It was first seen in Kentucky, where it proved very destructive to hemp and tobacco. About three years ago it was introduced into Iroquois County, Ill., and has increased rapidly. It is very destructive, particularly to hemp and tobacco, as it fastens itself upon the roots of these plants and draws from them their substance. Its growth in this country is more rank than in Europe, and it will doubtless be more of a pest here. When it once gets into a field it is very hard to eradicate, owing to the great multitude of seeds which it produces. The only remedy is to plant other crops for a few years, and by all means to be careful to obtain pure seeds from uninfested regions.

ORDER CHENOPODIACEÆ.

Saltwort (*Salsola Kali* var. *Tragus*).

(Plate X.)

Plant annual, robust. Stem much branched, spreading, very variable in size, often 4 to 6 feet high, glabrous. Leaves alternate; the earliest leaves filiform, 1 inch long, with a spiny tip; upper and floral leaves small, awl-shaped, much broadened at base, with a strong spiny point. Flowers very small in the axils of the leaves, subtended by two leaf-like bracts. Sepals 5, oblong, acute, glabrous, with a short wing or thick margin near the middle. Stamens 5. Styles 2. Seeds 1 with a coiled embryo.

The *Salsola Kali*, or common saltwort, is a native of this country, growing along the sandy seashore from New England south to Georgia. Although one of the earliest plants known in this country, it has never spread into cultivated fields or become a troublesome weed in any of the Eastern States.

The variety *Tragus* is not known to be native in this country, but its home is in Russia, and it has more than likely been introduced from that country either with forage seed or brought over in some way by emigrants.

However it may have become introduced in the West, one thing is certain, and that is that it is rapidly spreading and threatens to be one of the very worst weeds with which the farmer will have to contend. It has already gained a strong foothold in North and South Dakota, extending eastward into Minnesota and Wisconsin, and is common in northern Nebraska, and has been recently detected along railroad tracks near Denver, Colo. Some systematic and vigorous steps should be taken by the farmers of these Western States to eradicate this weed.

In Nebraska a bill was introduced in the last legislature with this end in view, but it failed of final passage. Some such action by the other States is to be commended.

This weed is called throughout the Northwest both Russian cactus and Russian thistle, although it is not properly a cactus nor a thistle. The attention of this Department was not called to this plant until the present year, although it is said to have been seen in this country for four or five years past. It is rapidly spreading over the Dakotas, and will become a most dangerous pest to the farmers unless its progress is in some way checked. This weed is a rapid grower and soon takes entire possession of neglected fields. It is an annual, and with careful and timely cultivation it can easily be exterminated. The Dakota farmers are much troubled by it, as it comes up after the wheat is cut and, overrunning the fields, it blossoms and matures seed for another year. In such cases early plowing is recommended, as then the young plants may be turned under and killed; then care should be taken that plants are not allowed to mature seed in waste places. This plant acts as a tumble-weed in the fall and winter, and in this way scatters its seeds over a wide territory. Mr. Norman S. French, of Grand Rapids, N. Dak., to whom this Department is indebted for first sending us specimens of this weed, writes:

This weed was first seen in this vicinity about four or five years ago. It was observed around the stock yards of the Milwaukee and St. Paul and Chicago Railroad at Ellendale and Monango, in Dicky County, and at Edgeley in this county, (La Moure). Intelligent Russians have told me that the weed grows abundantly in southern Russia, in the vicinity of Odessa, where it is locally known as the Tartar thistle, and it is supposed to have been brought to America by Russian Jews in some manner not known.

The points of the leaves in age become indurated and sharp pointed. This causes great annoyance to farmers, for in harvesting and fall-plowing the legs of the horses are cut by them, even when protected by leather or rubber.

Mr. Warren Upham, assistant geologist, U. S. Geological Survey, writes to me under date September 23, 1891, as follows:

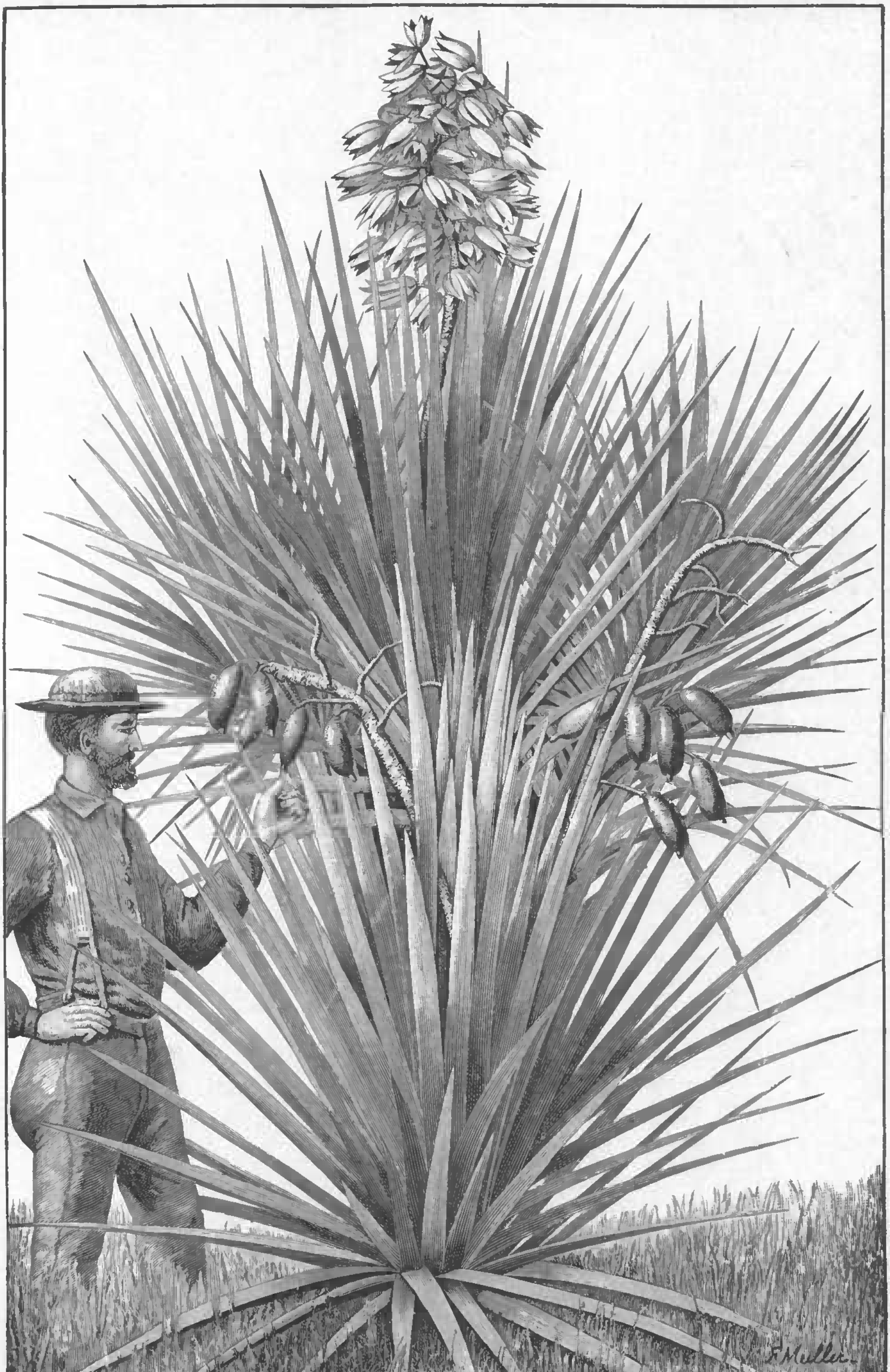
During my travels for geologic exploration in North Dakota in 1889 I saw your weed *Salsola* growing on a railway embankment near Clement, which is a few miles west of Oakes, and again as a weed on a sandy cultivated field of the Souris cottonland, near Towner. The habit of the plant resembles that of *Amarantus albus* L. It forms a stiff, prickly, rather compact, green bunch 2 to 3 feet in diameter and of hemispherical form.

S. W. Narregang, president of the Dakota Irrigation Company, writes, under date October 28, 1891, to the Department, as follows:

I send you herewith a fair specimen of the Russian thistle; it was impossible to obtain a perfect sample, because at this season the plant becomes brittle and breaks from the roots. I dug a small root and fastened it to the stock of the thistle. They grow much larger than the specimen, often three times as large, forming plants 6 feet in diameter—as large as a large wagon wheel. In reply to your question as to the time of its first appearance I would say that we first saw it three years ago. Since that time it has steadily increased, until at present the greater portion of South Dakota east of the Missouri River is infested with the thistle, particularly the strip of country extending from Eureka, Campbell County, southeasterly to Sioux Falls, which is covered thickly with this weed. This obnoxious weed has become so formidable in some portions of the State, notably in Scotland, S. Dak., where the Russians formerly settled, that many farmers are driven from their homes on account of it. A man who was there some time ago states that farmers were leaving their land by the dozens, simply because of this evil. As to the soil it affects, the plants are found in different soil, but thrive best in high dry places, railroads being the favorite position, and the poorer the soil the more vigorously it grows. It is also found growing abundantly in cultivated fields, springing up among crops that are being cultivated, especially in wheat fields, but not as much in cornfields, as there they have a

chance to kill the weeds as fast as they start. It is never found in low wet places, and very seldom on the unbroken prairie. The seed is similar to the old-fashioned tumble-weed, and as it has millions of seeds, any field where one of these plants has grown will be literally covered with the seeds. Plowing seems to have no effect upon it; perhaps summer fallowing might in a measure stop its growth. As these plants appeared during the last two or three dry seasons and do not thrive on low ground, it seems strong evidence that they will disappear when we get an ordinary and sufficient amount of rainfall. From the best authority I can obtain there is no question but that the Russians brought the seed to this country. It is claimed that the tender plants make good feed for stock; I have noticed that cattle and sheep eat them when the weeds are very young, but the plant grows quickly and in a short time the stalk becomes hard and then nothing will touch it. It is becoming a very serious question with our farmers how to free their land at this time, and unless some method is devised to stop its growth or exterminate it a great many acres in this country will become valueless in a very short time.

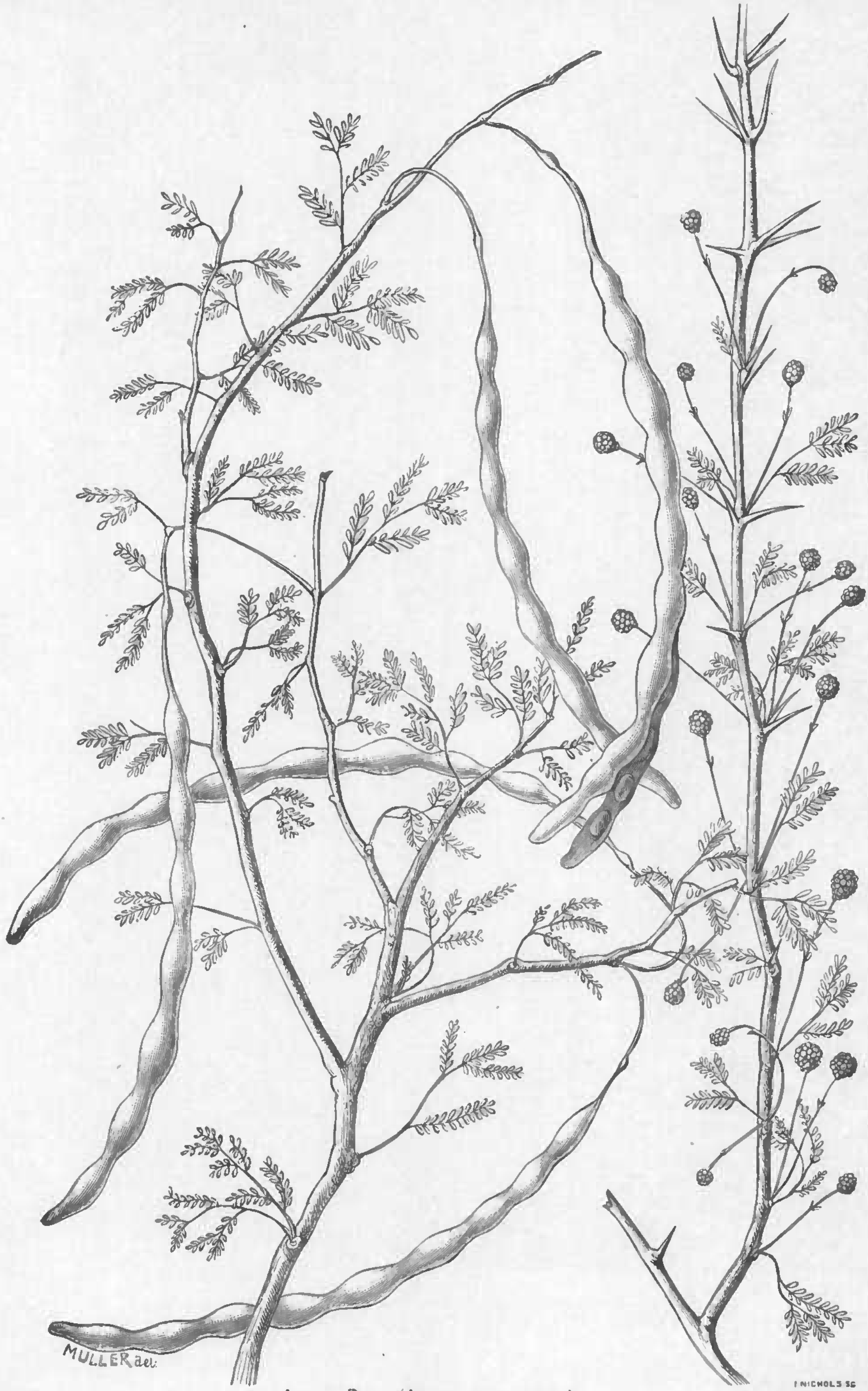
MESQUIT (PROSOPIS JULIFLORA).



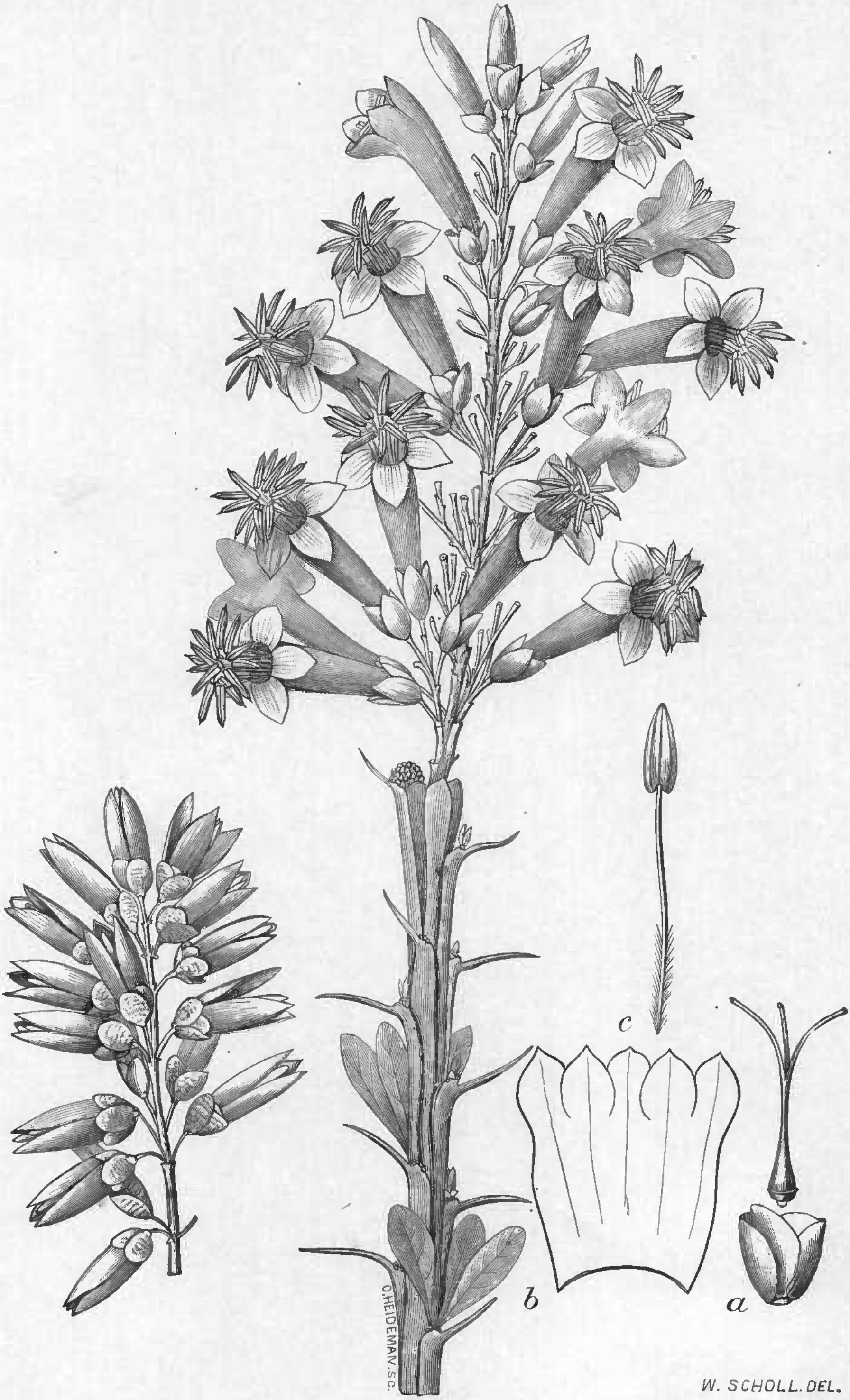
SPANISH BAYONET (YUCCA BACCATA).

W. SCHOLL. del.

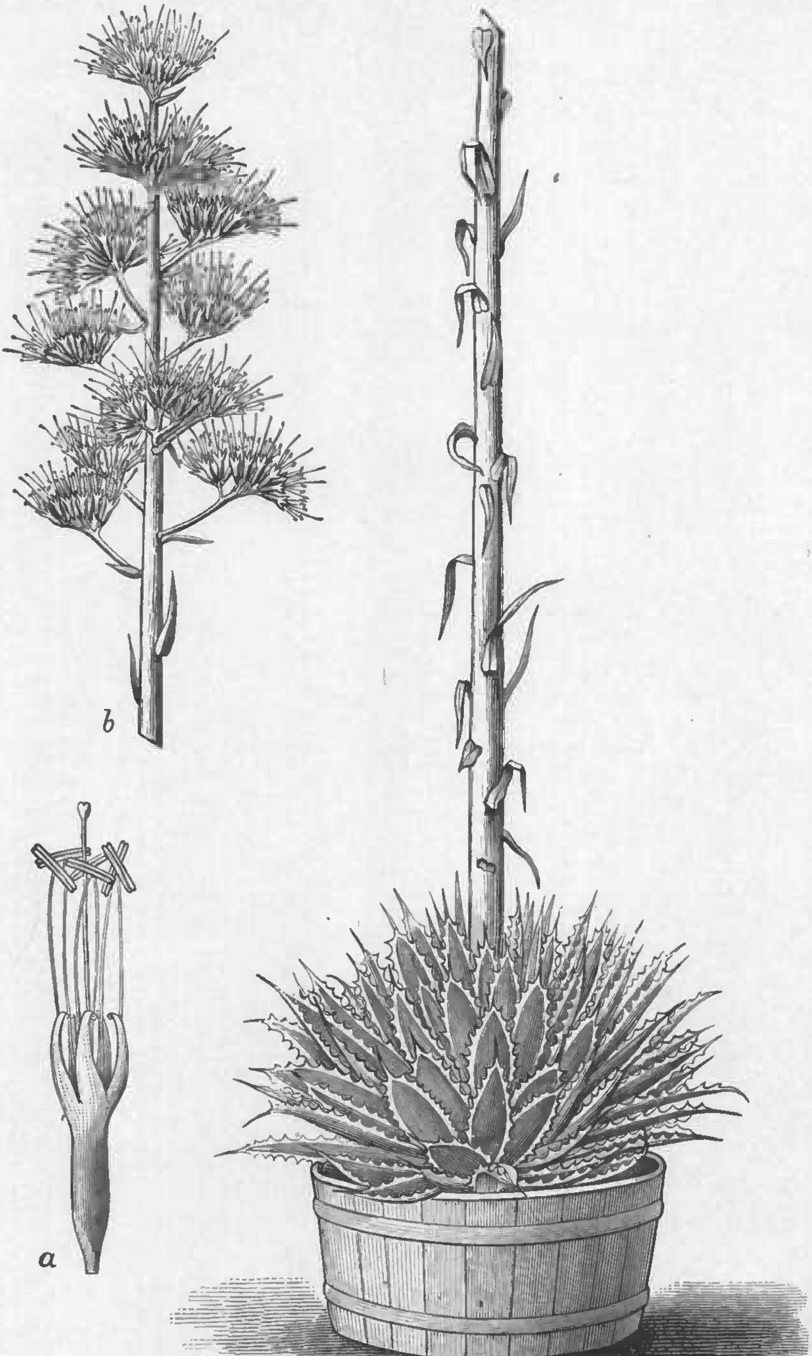
CREOSOTE BUSH (LARREA MEXICANA).



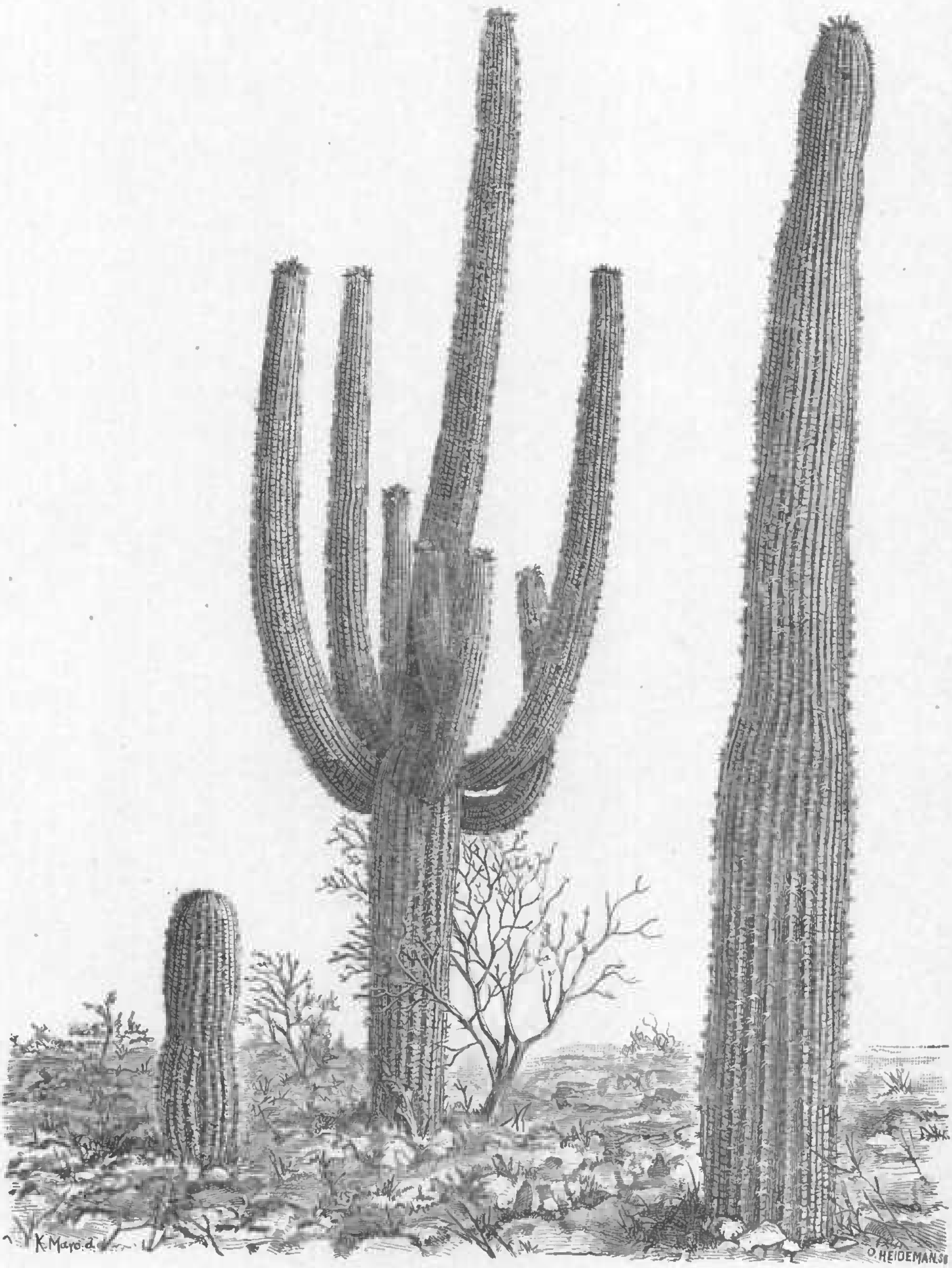
ACACIA BUSH (ACACIA CONSTRICTA).



CANDLEWOOD (FOUQUIERA SPLENDENS).

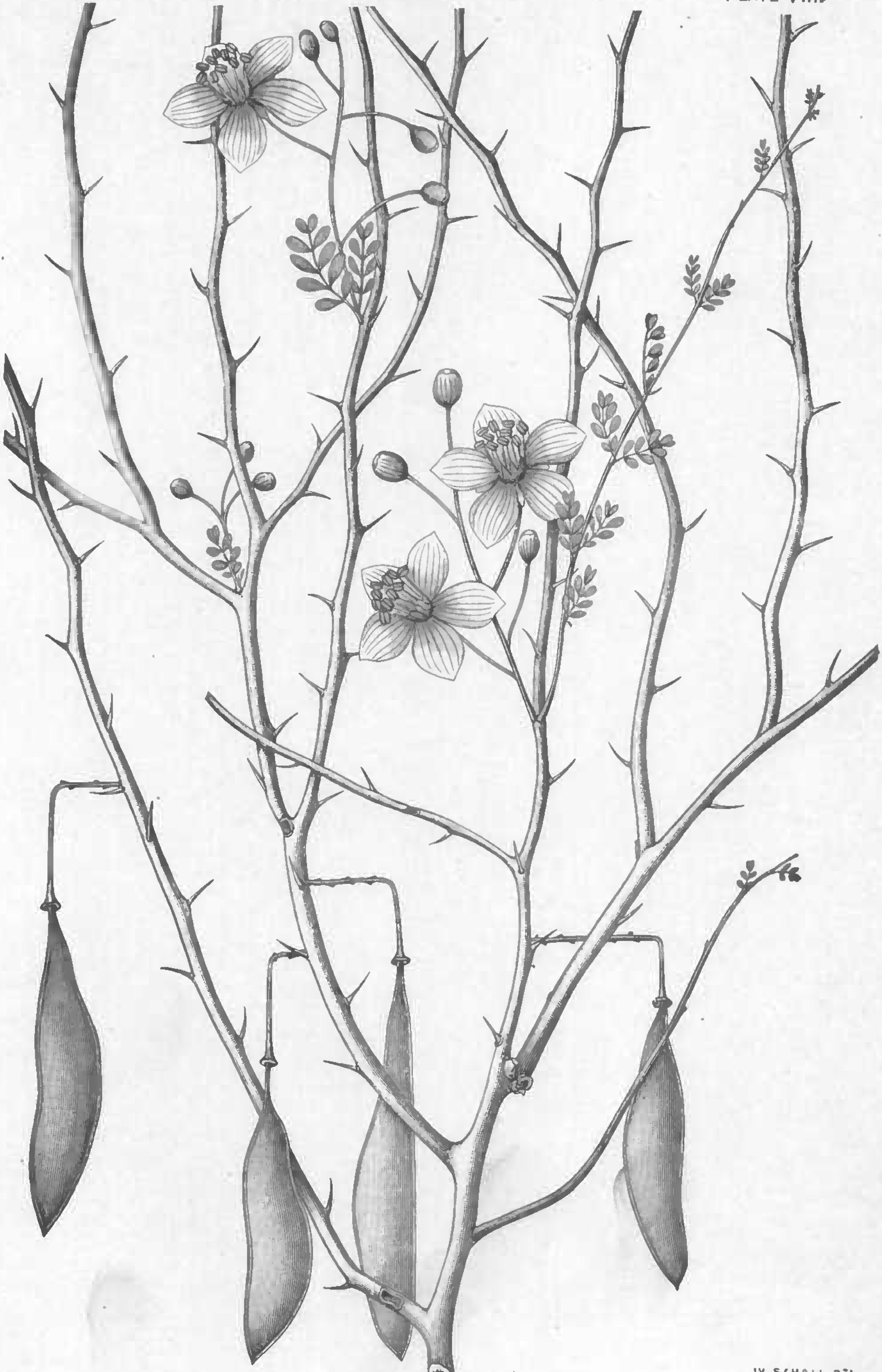


AMOLE (AGAVE PARRYI).



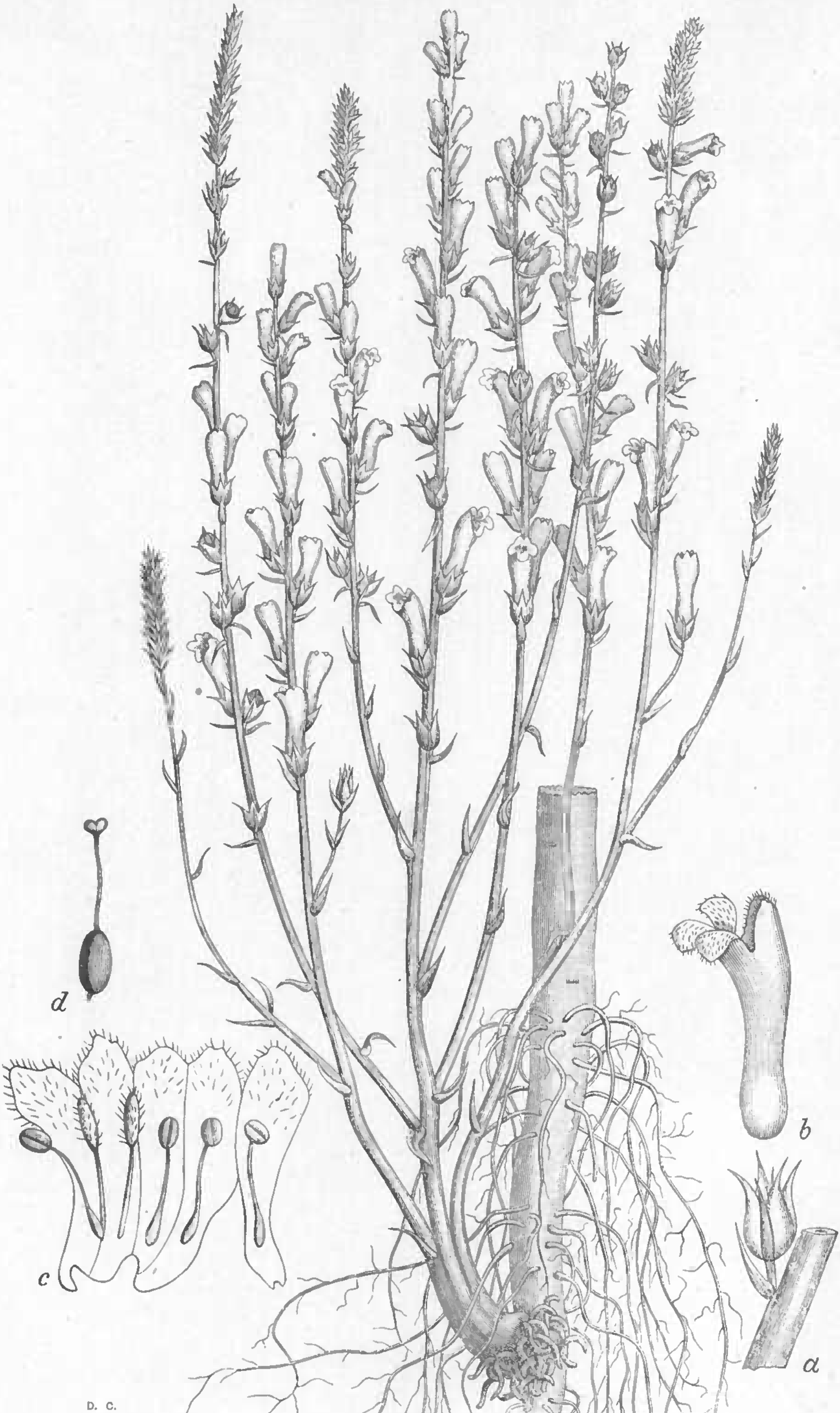
GIANT CACTUS (CEREUS GIGANTEUS).

PLATE VIII.

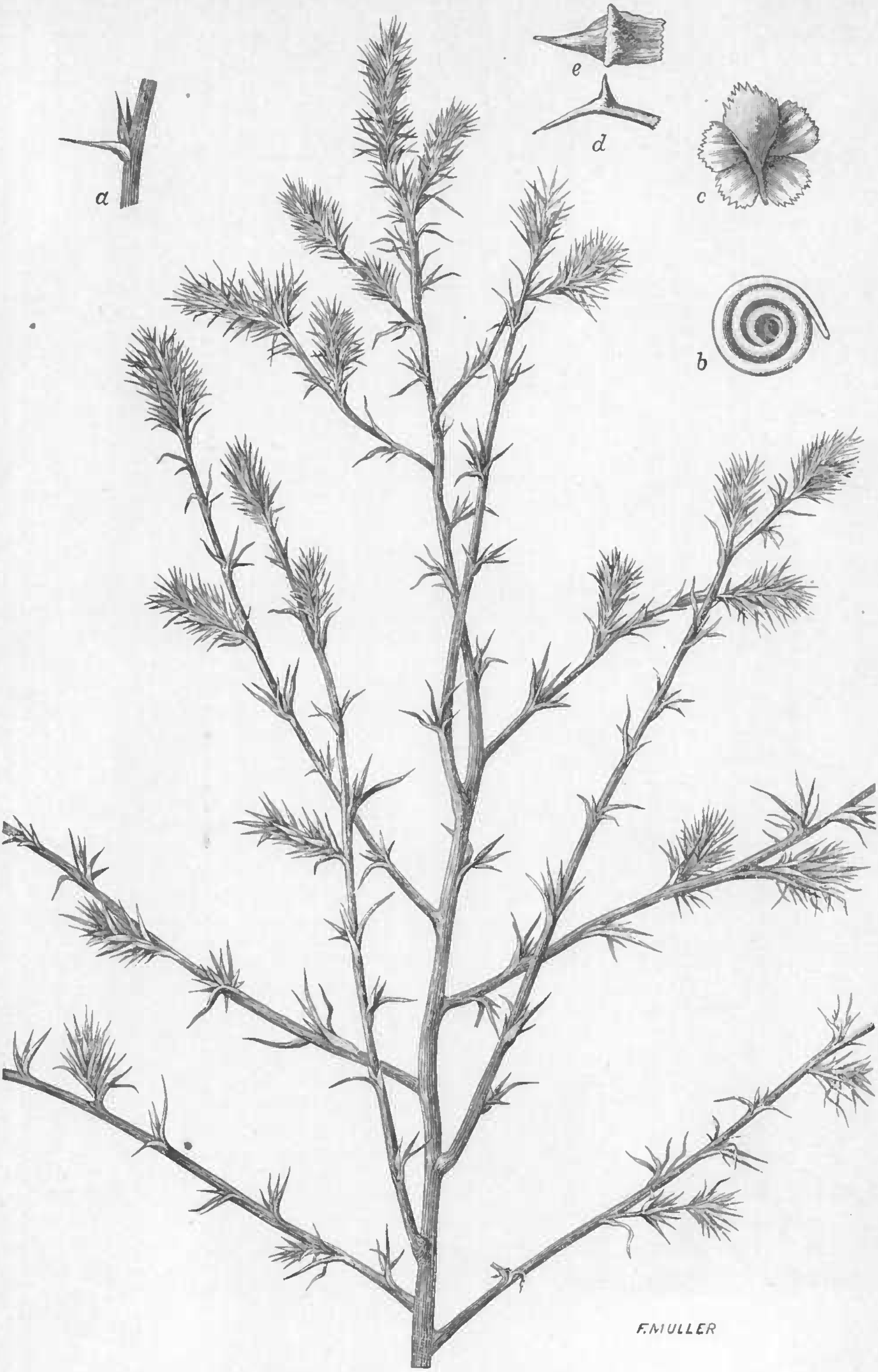


W. SCHOLL DEL.

PALO VERDE (PARKINSONIA TORREYANA).



BROOMRAPE (OROBANCHE RAMOSA).



SALTWORT (SALSOLA KALI VAR. TRAGUS).

REPORT OF THE CHIEF OF THE DIVISION OF VEGETABLE PATHOLOGY.

SIR: I have the honor to submit herewith my annual report, summarizing the work of my division for the year 1891.

Respectfully,

B. T. GALLOWAY,
Chief.

Hon. J. M. RUSK,
Secretary.

PUBLICATIONS AND CORRESPONDENCE.

Since my last report three numbers of the Journal of Mycology have been issued from this division; also Farmers' Bulletin No. 4, Circulars 10 and 11, and Bulletin No. 1.

The Journal of Mycology contains, among other things, papers on the treatment of black rot of grapes, pear leaf-blight and scab, apple scab, anthracnose of cotton, and other diseases; also illustrated articles on tuberculosis of the olive, ripe rot of grapes and apples, anthracnose of cotton, blackberry rust, peach rosette, sweet-potato black rot, diseases of the orange, peach blight, new spraying-pumps, etc. The index to North American mycological literature has been continued, and, judging from the many favorable comments received, it has proved of great value to experiment station workers and others.

A large edition of Farmers' Bulletin No. 4 was issued, but despite this it was practically exhausted in a short time. The bulletin gave in brief, practical form an account of several of the most destructive diseases of the grape and methods of combating the same. Over ten thousand grape-growers in the United States received this bulletin, which was distributed sufficiently early in the season to be put to practical use. Circular No. 10 gave a short account of some common diseases affecting nursery stock and the best means of holding them in check. Circular No. 11 was designed to collect information regarding the number of grape-growers in the United States who had adopted the methods of treating their vines recommended in Farmers' Bulletin No. 4.

The publication and distribution of this circular are part of a plan to collect reliable statistics bearing on the actual money value to farmers, fruit-growers, and others of the suggestions and recommendations made by this division. In my opinion, such information is of the utmost importance, as it shows in an indisputable manner the true value of the work of this Department as it is usually regarded by the farmer. Thus the replies to Circular No. 11, based on careful records, show that by following the recommendations of the division in treating a single dis-

ease of the grape, growers of this fruit saved an amount equal to four times the annual appropriation for the division.

In addition to the foregoing publications, a bulletin on the California vine disease is ready for the printer, and another, on the practical work of the division the past season, is being prepared.

In the matter of correspondence there has been a considerable increase over last year in the number of letters received and answered. As usual, much of my own time has been devoted to this work, but the assistants also have contributed material aid in the matter.

MISCELLANEOUS SUBJECTS.

The herbarium of the division has reached a condition requiring the entire attention of one assistant and a considerable part of the time of another. All specimens, whether they are from published exsiccati or sent in by collectors and others, are mounted in the usual pockets on full-sized herbarium sheets. Each sheet contains but one species, and if it be filled with specimens from different localities or material from one place, designed to illustrate some particular point, another sheet is inserted. The species are arranged alphabetically, the genera according to Saccardo's Sylloge Fungorum. The entire herbarium is indexed by a card catalogue according to hosts and fungi, the cards containing the herbarium references as well as others giving published descriptions, etc.

There are now in the herbarium 7,865 standard sheets, upon which are mounted 16,397 specimens, representing 779 genera and 6,424 species. The more important published exsiccati are represented, the sets in most cases being complete.

In addition to the index work carried on in connection with the herbarium, correspondence, etc., a record of the literature of the world on plant diseases will hereafter be kept. Beginning with 1891, this index will, for the benefit of workers in this country, be published in the Journal of Mycology. An effort will be put forth to have the index as complete as possible, brief abstracts of each paper being given to make the work more valuable.

The divisional force now consists of Miss E. A. Southworth, Miss May Varney, Mr. Erwin F. Smith, Mr. D. G. Fairchild, Mr. Newton B. Pierce, Mr. M. B. Waite, Mr. W. T. Swingle, Mr. P. H. Dorsett, and Mr. Joseph F. James. Messrs. Smith, Pierce, and Waite have, as heretofore, devoted most of their time, respectively, to peach yellows, the California vine disease, and pear blight. The rest of the assistants have been engaged upon various subjects, publishing their results in full mainly in the Journal of Mycology.

LABORATORY INVESTIGATIONS.

The work in the laboratory the past year has been fraught with more than usual interest. Aside from the investigations noticed elsewhere on pear blight, peach yellows, work in California, New York, etc., the special subjects under consideration have been diseases of garden crops, such as celery, lettuce, cucumbers, parsnips, etc.; diseases of cereals, including rust of wheat, rye, and oats; blights and rots of the Irish potato; diseases of the sweet potato; blight and rot of the tomato, and diseases affecting floricultural interests. Some attention has also been given to fungous and bacterial diseases of insects.

In view of the great and growing importance of market gardening

and its kindred industry, truck farming, plans are being made for special work having a bearing on this subject. A number of interesting discoveries in connection with it have already been made, and it is believed that others of great practical value will follow.

In connection with the work on diseases of cereals, the bacterial disease of oats mentioned in my last report has received further attention. In 1890 this disease prevailed throughout the entire country west of the Mississippi River, causing losses ranging from 25 to 75 per cent of the crop. This year not a single complaint of the trouble was received, and in only one instance was the disease observed, that being in a field near Washington. As already announced, the laboratory investigations have shown that the disease is bacterial, a bacillus being constantly found in connection with the trouble. Inoculations with pure cultures of this germ give rise to the disease in from six to ten days. Further study of the disease the past year has brought out the fact that the germs live over winter on the seed. In no case, however, have they been found in the soil, nor have they been obtained from volunteer oat plants which survived the winter. Seed obtained from regions where the disease did not exist were free from the blight-producing organism, and these facts led to a series of experiments which are noticed under "Field Experiments."

In connection with the work on sweet-potato diseases, the life history of the fungus causing what is known as "black rot" has been thoroughly worked out. A full account of the investigation is given in the Journal of Mycology (Vol. VII, No. 1).

Considerable interest has of late years been manifested by farmers and others as to the possibility of destroying insects by spreading certain diseases to which they are subject. Several diseases of this nature having been called to the attention of the division the past year, attempts were made to arrive at some definite conclusions as regards their cause and the possibility of turning this knowledge to practical account. Early in the spring, specimens of the Southern cabbage-worm (*Plusia brassicæ*), affected with a disease, were sent in by Dr. J. C. Neal, of Florida. According to Dr. Neal, the disease was destroying a great many worms in the vicinity of Lake City and elsewhere in the State. No fungus being found in connection with the trouble, bacteriological methods were resorted to in the hope of throwing light on the subject. In every case two organisms were found constantly associated with the disease. These organisms were obtained from material sent in a number of times by Dr. Neal, as well as from worms found in Alabama, Mississippi, and Maryland. The germs were grown successfully on beef peptone, glycerine, and potato agar, on various nutrient gelatine preparations, and in various broths. Two hundred inoculations made with pure cultures gave no definite results. In no case was the typical, or, for that matter, any disease produced, despite the fact that worms of all ages were inoculated by feeding cabbage leaves previously sprayed with vigorous broth cultures and in various other ways. It is hoped another season's work will give more definite results, but it can not be denied that many difficulties are yet to be surmounted. In all cases a study of the anatomy and physiology of the insect is highly important, as furnishing a clew upon which the more practical investigations may be based.

FIELD EXPERIMENTS.

For the purpose of teaching farmers, fruit-growers, and others in a practical way the methods employed in combating plant diseases, extensive experiments were made the past year. A large part of this

work was conducted in the vicinity of Washington, where it was at all times subject to personal inspection and supervision. Agents of the division actively engaged in work of this kind were also located in New York, Pennsylvania, Maryland, Wisconsin, and California. The work may be properly classified under (1) treatment of the diseases of nursery stock; (2) treatment of apple, pear, peach, plum, cherry, and quince diseases in the orchard; (3) treatment of grape diseases; (4) treatment of black rot of sweet potatoes; and (5) treatment of oat blight.

TREATMENT OF THE DISEASES OF NURSERY STOCK.

In 1889 a series of experiments having for their object the prevention of several destructive diseases in the nursery were inaugurated. As a result of this work it was shown that leaf-blight of the pear, cherry, plum, and quince, powdery mildew of the apple, and other similar diseases could be largely prevented at comparatively little expense. When the work was begun it was necessary to start with trees which had already been subject to attacks of the diseases mentioned during one or more seasons. This, of course, made the work less valuable than it would have been had the first treatment been given to seedlings as soon as they were above ground. To overcome this difficulty, as well as to obtain information of a definite nature on other points having a practical bearing, a new series of experiments were begun this year. The object of this work may be summarized as follows:

(1) To determine the possibility of growing French and American pear seedlings in this country. Nearly all stock of this kind is now imported from France, but there is nothing in the way of growing it here excepting the leaf-blight fungus, which usually comes on as soon as the seedlings are above ground.

(2) To ascertain, if possible, the actual effect of spraying the trees, starting with the seedling and continuing the work until the stock is of salable size. It is believed that by protecting the trees from the attacks of the fungous enemies to which they are every year subject, it will be possible to obtain in two seasons a growth equal to three under ordinary conditions. This means to the nurseryman an increase in the value of his stock of 25 per cent or more.

(3) To determine the relative value, so far as resistance to disease is concerned, of different stocks; as for example, Japan *versus* French pear seedlings, Mariana plum *versus* Myrobolan, etc.

To carry out this work in all of its details about 8,000 plum, apple, cherry, and quince were planted in the nurseries of Franklin Davis & Co., near Washington. The same number were planted at Geneva, N. Y., on the grounds of the experiment station, thus affording a thorough test of the matter under different conditions of soil and climate, something that is always desirable in work of this kind.

While encouraging results have followed the first season's work, it is too early to say anything definite as to what the final outcome will be. The results of the season's experiments will be set forth in a bulletin now in preparation.

TREATMENT OF APPLE, PEAR, PEACH, PLUM, CHERRY, AND QUINCE DISEASES IN THE ORCHARD.

This work was carried on with a view of obtaining more accurate information as regards the cheapest, most practical, and efficient means of preventing apple scab, pear scab, and leaf-blight, peach rot, plum, quince, and cherry leaf-blight. As heretofore, the work on apple scab was conducted, under my direction, by Prof. E. S. Goff, in the orchard of A. L. Hatch, near Ithaca, Wis. The fungicides tested were the ammoniacal copper carbonate solution, copper carbonate suspended in

water, copper sulphate used in solution as a winter wash, and Bordeaux mixture. Paris green, London purple, and kerosene emulsion were also used, combined with fungicides. The foregoing were prepared in the following manner:

Ammoniacal solution of copper carbonate by mixing 1 ounce of precipitated carbonate of copper and 6 ounces of carbonate of ammonia, then dissolving in 10 gallons of water. It was used with and without lime, no injury to the leaves resulting in either case.

Copper carbonate in suspension was prepared by simply stirring 1 pound of the carbonate in 100 gallons of water.

The solution of copper sulphate was made by dissolving 1 pound of the sulphate in 25 gallons of water.

Bordeaux mixture was prepared in the ordinary way, using 6 pounds of copper sulphate, 4 pounds of lime, and 22 gallons of water.

Paris green was mixed with water at the rate of 1 pound to 100 gallons, a little lime being added to neutralize the arsenic.

Kerosene emulsion was made in the usual way and diluted at the rate of 1 gallon to 100 gallons of water.

A mechanical mixture was also made by pumping kerosene and water together through a nozzle.

London purple solution was made by mixing 1 pound of the purple in 200 gallons of water. This strength was used for the first treatment; afterwards the amount of water was reduced to 100 gallons.

According to Prof. Goff, it was found impossible to secure a combination of the London purple with either the kerosene emulsion or the mechanical mixture of kerosene and water. The general plan of the work, as set forth in the instructions to Prof. Goff, was as follows:

(1) To determine the efficacy of winter and early spring treatments, with and without summer treatments.

Trees were sprayed with different fungicides before growth commenced, and not afterward. Others were sprayed before growth commenced, and again just before bloom, and not afterward. Others were first sprayed just before bloom, and three times after the falling of the petals, the treatments extending to midsummer. Still others were sprayed before growth commenced, just before bloom, and with three after-treatments.

(2) To determine the comparative efficacy of the different fungicides used.

The copper sulphate was used only in the winter treatment; the Paris green and kerosene were used in winter and summer treatments, and the copper carbonate and Bordeaux mixture were used in the winter, spring, and summer treatments.

(3) To determine if fungi and insects may be effectually treated at the same time.

Paris green was used alone, to discover if it may not have virtue both as an insecticide and as a fungicide. London purple and the kerosene emulsion were also used in connection with the fungicide preparations.

Two trees of medium size, of the Haas or Fall Queen variety, that promised a good crop of fruit, were subjected to all of the treatments indicated above, and their crop compared with that of two other trees not sprayed at all.

A number of interesting points were brought out by this work, the most important of which are summarized below:

(1) The treatment with copper sulphate before growth started in spring was to a certain extent beneficial in reducing the amount of scab.

(2) The ammoniacal carbonate preparation was less beneficial than copper carbonate suspended in water.

(3) Bordeaux mixture was more efficient than either of the carbonate preparations.

(4) Paris green used alone was fully as efficient in preventing scab as Bordeaux mixture, and as a preventive against the codling-moth it was superior to London purple or the kerosene emulsion.

Scab and leaf-blight of the pear were under treatment in the orchard of Dr. Maxwell, near Still Pond, Md. In this work an endeavor was made to obtain information on the following points:

(1) A comparison of ten fungicides, eight containing approximately the same amount of the compound of copper and two containing no copper at all, as regards their effect on the healthy fruit and leaves, their qualities as preventives of leaf-blight, and the cost of preparation and application. The fungicides used were the same as those described in detail under treatment of grape diseases.

(2) The effect on leaf-blight, scab, and cracking of two early treatments, one when the flowers were opening and one just as the petals were falling.

(3) Effect of three treatments, as ordinarily given, compared with seven.

For the experiment a block of Duchess dwarf trees was selected. The block contained fifty trees, thirty of which were sprayed and twenty left for control. The trees to be treated were divided into ten plats of three trees each, and, alternating with these, ten plats of two trees each were left for control. Two trees in each treated plat received the early sprayings, which were made on April 14, before the flowers had entirely opened. These were numbered 1, 3, 5, 7, etc. One tree in each plat received but two sprayings—namely, on April 25, when the pears were just forming, and on May 9, when the fruits were the size of peas. These trees were numbered 2, 4, 6, and so on. After three sprayings had been given the early treated trees, or those numbered 1, 3, 5, etc., the treatment for one tree of each plat was discontinued, leaving one tree which was to receive the full season's treatment of seven sprayings. It will thus be seen that this plan endeavored to cover the questions already set forth.

The details of this experiment have been prepared for publication in a special bulletin, which it is hoped may be issued before the next season opens.

This year, for the first time, an effort was made to prevent peach rot, a disease which annually causes thousands of dollars damage on the Maryland and Delaware peninsulas and elsewhere. The experiments were confined to the early varieties, chiefly because they are usually the most subject to rot. Sulphur, a solution of potassium sulphide, Bordeaux mixture, and the ammoniacal solution of copper carbonate were used. Applications of these preparations were made in two ways, namely, (1) at intervals of ten days throughout the season, beginning when the trees were in bloom and ending when the fruit was ripe; (2) at intervals of five days, beginning fifteen days before the fruit ripened. In no case was there any appreciable difference, so far as rot was concerned, between the treated trees and those alongside left for control. If any benefit at all resulted, it was where sulphur was used throughout the season. The experiment demonstrated, however, that Bordeaux mixture was, under certain conditions, positively dangerous when applied to peach foliage. The trees treated with this preparation lost all of their foliage, and even the flowers and young wood were killed. As soon as the bad effects were noticed the treatment was discontinued, after which the trees put out more leaves and by fall had fully recovered.

While this first attempt to prevent peach rot is discouraging, it does not call for an abandonment of the subject. Another year the work will be undertaken on a different basis, and it is hoped the results will be more satisfactory.

The disease of the plum, cherry, and quince, while caused by at least two different fungi,* are known under the general name of leaf-blight. Extensive experiments were made in the treatment of these diseases near Washington; also at Geneva, N. Y., and elsewhere in the same State. The results of this work will be given with those on other diseases to which reference has been made.

TREATMENT OF GRAPE DISEASES.

The treatment of grape diseases was confined entirely to one vineyard near Sterling, Va., 30 miles southwest of Washington, on the Richmond and Danville Railroad. This vineyard was selected for a number of reasons, the first being its proximity to headquarters; second, the crop had for a number of years been almost totally destroyed by rot and mildew; and, third, that it had received every attention in the way of pruning, cultivation of the soil, etc. The owner of the property, Mr. John A. Svedberg, kindly placed the entire vineyard at our disposal, and in many other ways aided materially in the work.

The experiments were designed to throw light on the following points, none of which, so far as known, had been subjected to trials of this kind before:

(1) A comparison of eight fungicides, each depositing on the foliage approximately the same amount of the compound of copper as the ammoniacal copper carbonate solution, viz, .1 ounce per gallon.

(2) A comparison of two fungicides of same strength as (1), but containing no copper, with the foregoing preparations.

(3) A comparison of the Bordeaux mixture full strength with half strength, and early treatments with late.

The fungicides used under (1) and (2) were as follows:

1. AMMONIACAL COPPER CARBONATE SOLUTION.

Copper carbonate	ounces	½
Aqua ammonia (26°)	do	6
Water	gallons	4½

2. MODIFIED EAU CELESTE.

Copper sulphate	ounces	2½
Sodium carbonate, cryst	do	3
Aqua ammonia (26°)	do	2
Water	gallons	6½

3. PRECIPITATED COPPER CARBONATE SOLUTION.

Copper sulphate	ounces	2½
Sodium carbonate, cryst	do	3
Water	gallons	6½

4. COPPER SACCHARATE.

Copper sulphate	ounces	2½
Sodium carbonate, cryst	do	3
Cheap molasses	do	2
Water	gallons	6½

5. GLUE MIXTURE.

Copper sulphate	ounces	2½
Sodium carbonate, cryst	do	3
Le Pagés liquid glue	do	2
Water	gallons	6½

*Cherry and plum leaf-blight are due to *Cylindrosporium padi*, Karst. Quince leaf-blight to *Entomosporium maculatum*, Lév.

6. BORDEAUX MIXTURE.

Copper sulphate	ounces..	4
Lime, fresh	do....	4
Water	gallons..	7½

7. COPPER ACETATE SOLUTION.

Copper acetate, basic	ounces..	½
Water	gallons..	5

8. COPPER CHLORIDE MIXTURE.

Copper sulphate	ounces..	½
Calcium chloride	do....	¼
Water	gallons..	5

9. POTASSIUM SULPHIDE SOLUTION.

Potassium sulphide	ounces..	½
Water	gallons..	5

10. SODIUM HYPOSULPHITE SOLUTION.

Sodium hyposulphite	ounces..	½
Water	gallons..	5

For the comparative experiments with Bordeaux mixture, as outlined under (3), the following formulas were used:

1. BORDEAUX MIXTURE, FULL STRENGTH.

Copper sulphate	pounds..	6
Lime, fresh	do....	4
Water	gallons..	22

2. BORDEAUX MIXTURE, HALF STRENGTH.

Copper sulphate	pounds..	3
Lime, fresh	do....	2
Water	gallons..	22

In view of the fact that the ammoniacal solution of copper carbonate has proved one of the cheapest and best fungicides, it was thought desirable to place the others on an equal footing with it. The vines selected for this work were Concords eight years old, which were trained to stakes 8 feet high, set 6 feet apart each way. Seven hundred and fifty vines were selected for the experiment, 200 of which were treated, and the remainder, 350, left for control. Each treated plat of twenty vines was almost wholly surrounded by untreated ones, thus affording a most severe test for the experiment. All the plats received seven sprayings, each being given on the same day. The first spraying was made on April 27, when the leaves were from 1 to 1½ inches in diameter. The second and third sprayings were made on May 13 and 25, respectively, just as fruit was forming. After this, sprayings were made every ten or twelve days until the fruit showed signs of ripening.

Briefly summing up the results of the work, it may be said—

(1) That from 20 to 60 per cent of the fruit formed on the untreated vines was destroyed or rendered worthless by rot.

(2) On the treated plats where the precipitated copper carbonate solution and copper saccharate were used 100 per cent of the fruit was saved. Ammoniacal solution, modified eau celeste, glue, and Bordeaux mixture each saved 99 per cent while the others saved 90 to 96 per cent of the crop. The per cent saved on the plats treated with potassium sulphide solution and sodium hyposulphite was 96 and 70, respectively.

(3) Taking into consideration such questions as injurious effects on leaves, fruit, and young wood, cost, ease of application and preparation, Bordeaux mixture leads the list, while ammoniacal solution, modified eau celeste, copper saccharate, and glue mixture follow in the order named.

One of the most remarkable things in connection with the experiment is that Bordeaux mixture containing only 12 ounces of copper sulphate and 12 ounces of lime to 22 gallons of water was as effective against rot as the old formula of 6 pounds of copper sulphate and 4 pounds of lime to 22 gallons of water. If further experiments corroborate these, the cost of treatment can be reduced fully 90 per cent.

In the experiment with Bordeaux mixture full strength, half strength, early and late treatments, etc., 160 Concord vines were selected. Half of these were subjected to treatment and the remainder were left for control. Summarized briefly, the more important results of this work are as follows:

(1) In every case the early treatments gave the best results.

(2) There was little difference between the plats treated early with full-strength and those treated in the same way with the half-strength mixture.

(3) The average amount of fruit saved on the plats treated early with full-strength mixture was 96 per cent; on plats treated early with half-strength 86.5 per cent of the fruit was saved. On plats treated late with full and half strength the fruit saved was 26 and 35 per cent, respectively; on the untreated plats 15 per cent of the fruit was saved. Altogether this experiment was one of the most interesting and instructive yet conducted by the division, many points of great practical importance, which can not well be mentioned here, being brought out.

TREATMENT OF BLACK ROT OF SWEET POTATOES.

Experiments in the treatment of sweet-potato black rot were carried on at Penn's Grove, N. J., in coöperation with Dr. B. D. Halsted, of the New Jersey Experiment Station.

The work was planned to throw light upon the following points:

(1) The influence of healthy and diseased seed potatoes upon the amount of black rot.

(2) The effect of treating healthy and diseased seed potatoes with a fungicide before planting.

(3) The effect of treating the sprouts from healthy and diseased seed-potatoes with a fungicide while in the propagating bed.

(4) The effect of spraying diseased and healthy sprouts with a fungicide from the time of planting in the field until the runners had attained a length of 2 feet.

(5) The effect of treating potatoes previous to storing with four different fungicides, to prevent the spread of black rot in the bin.

The unusual absence of the disease in the field experimented with rendered the results negative in some points. It is hoped, however, that the continuation of the experiments will furnish valuable suggestions to potato-growers. Even at this stage of the experiment the wisdom of planting perfectly healthy seed and transferring to the field only healthy sprouts has been clearly demonstrated.

TREATMENT OF OAT BLIGHT.

In the experiment having in view the prevention of oat blight, to which reference has been made under "Laboratory Investigations," the work was confined mainly to the planting of seed from infested and non-infested regions. An effort was also made to determine the effect of early and late planting on the disease. An acre of oats consisting of sixteen plats, planted so as to cover the foregoing points, was sown near Washington. Two acres planted in a similar manner were under observation in Pennsylvania. Prof. J. H. Fletcher, of the Central Experiment Farm at Ottawa, Canada, also kindly planted a number of plats with seed sent from this country.

As stated elsewhere, no blight whatever appeared, and such being the case, the results were wholly negative,

SPRAYING MACHINERY.

It is gratifying to announce that manufacturers all over the country are manifesting great interest in machinery suitable for the work suggested by the division. There are now no less than a dozen knapsack pumps made in this country, a striking contrast to the condition of affairs four years ago, when all machinery of this kind was of necessity imported from Europe. The division has designed three sprayers of the knapsack pattern, all of which are now being made by manufacturers of pumps in various parts of the United States. As a result of the competition brought about by putting the various styles on the market, the prices have been reduced to such an extent that the pumps are now within the reach of all.

Realizing the importance of cheap and efficient horse-power machines for such work as spraying potatoes, nursery stock, grapes, etc., an effort was made the past season to perfect something of this kind. A machine costing from $28 to $30 was designed, which, when drawn by one horse and operated by two men and a boy, will do the work of from four to six knapsack pumps. As yet, however, it has been found impossible to do the work as thoroughly with a machine of this kind as with one where everything is under the absolute control of the man holding the nozzle. By going over the ground twice, however, it is possible after some experience to reach nearly every leaf. In connection with experiments next season in the use of powders as fungicides, machines are being designed for the application of these substances.

WORK IN NEW YORK STATE.

At the earnest solicitation of a large number of western New York fruit-growers who were desirous of obtaining aid in treating a number of destructive plant diseases, Mr. D. G. Fairchild was sent to Geneva early in April and remained until the middle of October. Through the courtesy of Dr. Peter Collier, Mr. Fairchild was given rooms in the State Experiment Station building. Space on the station farm was also kindly placed at his disposal. The work for the season was devoted mainly to (1) experiments in the treatment of nursery stock; (2) treatment of apple scab; (3) treatment of leaf-blight of the plum in the orchard; (4) treatment of quince leaf-blight and fruit spot, and (5) investigation of a new currant disease.

In coöperation with the more prominent nurserymen in the vicinity of Geneva, Syracuse, Lockport, and Rochester, a block of nursery stock (pear, quince, cherry, plum, and apple) was planted upon the grounds of the State Experiment Station. The object of this experiment, which is still in progress, was to throw light upon the question of the advisability of treating nursery stock for the prevention of leaf-blight and powdery mildew. The varieties chosen for treatment were those reported to be most susceptible to the diseases, and from 500 to 2,000 stocks of each variety were treated. The details of the experiment, which is planned to cover a period of two years or more, will appear in a forthcoming bulletin.

In addition to the above experiment Mr. Fairchild directed the treatment in the nurseries about Geneva of several million pear and cherry stocks, and inspected the large nurseries of Smiths & Powell, of Syracuse. Owing to the favorable season and the absence of disease, many

nurserymen discontinued the treatment of their stock as likely to be useless; but those who continued the application of the fungicide were rewarded with foliage which remained uninjured until frost.

In connection with the main nursery experiment at Geneva a test of the comparative efficacy of the ammoniacal solution and Bordeaux mixture in the prevention of the leaf-blight of plum seedlings was made. Three treatments in July prevented the fall of the leaves, the Bordeaux mixture* proving superior to the ammoniacal solution.

At Brockport a series of experiments for the prevention of apple scab was made on forty trees in the orchard of Mr. Foster Udell. Four standard fungicides were applied, but, owing to the unusual freedom from scab of all the apples in the region, only negative results were obtained.

Through the aid of the owners two separate series of experiments in the large plum orchards of T. C. Maxwell & Bros. and A. Hammond were made. These were undertaken to ascertain if the early application of fungicides would prevent the plum leaf-blight † which often defoliates the trees before the ripening of the fruit. Six different fungicides were used in very weak solutions. These experiments, in part duplicate, show plainly the necessity of treatments being continued throughout the season, or at least as late as the 1st of August, if the foliage of the plum tree is to be retained until frost.

A comparative test was made of five different fungicides, to ascertain their relative value as preventives of the quince leaf-blight and fruit spot.‡ Twenty-four trees in the orchard of T. C. Maxwell & Bros. were treated, and estimates of the results show the effectiveness of three mixtures. They increased the percentage of fair fruit from 18 per cent to 35 per cent over that of adjoining trees and 40 per cent over the average of untreated trees. Three fungicides used in the proportion of about one-tenth of an ounce of the salt to a gallon of water, or 2¾ ounces to 25 gallons of water, were almost equally successful. The Bordeaux mixture,§ copper acetate, ||and the Perret mixture¶from this experiment stand first as preventives of the leaf-blight, while chloride of lime and potassium sulphide failed entirely to prevent the disease, and actually seemed to increase the amount of fruit spot and leaf-blight.

Through the kindness of Mr. John Burroughs, of West Park, N. Y., the presence of a new currant disease along the Hudson River was established. The disease was found to be confined to the eastern part of the State, being most severe in the neighborhood of West Park, Marlboro, and Highland. Laboratory investigations established the fungous nature of the disease and its consequent contagious character, and a series of successful inoculations prove the infectious nature of the malady. The

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*A weak formula was used in both cases. Ammoniacal solution containing 2 ounces copper carbonate in 20 gallons of water; Bordeaux mixture 2 pounds of copper sulphate, 1 pound of lime, 20 gallons of water.

† *Cylindrosporium padi*, Karsten.

‡ *Entomosporium maculatum*, Lév.

§ Formula—7.5 grams copper sulphate, 10 grams slaked lime, 2 gallons of water, equal about 5½ ounces of copper sulphate and 7½ ounces of quicklime in 50 gallons of water.

|| Formula—7.5 grams copper acetate, wet in 30 cubic centimeters of water and diluted with 2 gallons of water, equal 5½ ounces of acetate of copper wet with 1 quart of water and diluted with 50 gallons water.

¶ Formula—7.5 grams of copper sulphate, 8 grams of crystalized sodium carbonate, 5 grams of glue, and 2 gallons of water, equal about 5½ ounces of copper sulphate dissolved in 1 quart of water, 6 ounces of sal soda dissolved in 1 quart of water, the two mixed, and 4 ounces of liquid glue added before dilution with 50 gallons of water.

characteristics of the disease were found to be the wilting and final shriveling of all the leaves situated above the point of attack, and the presence on some portions of the cane of a dark zone of wood and bark one-half to 6 inches in length killed by the fungus. This is visible upon splitting the cane lengthwise. Cultures of the disease have failed to produce fruiting forms of the fungus and are held for further study.

INVESTIGATION OF PEACH YELLOWS AND PEACH ROSETTE.

Since my last report a bulletin, to which reference is elsewhere made, has been published on peach yellows. There are given in this bulletin the results obtained up to date by means of bud inoculations and excisions. The experiments were made with the greatest care; they cover a period of years and were repeated several times, so that the final results might be depended upon. The conclusions from the work are as follows:

(1) The disease is contagious, and may be conveyed by healthy-looking buds when these are taken from partly diseased trees.

(2) Only a small amount of infectious material is necessary to produce the disease, provided it is in the form of living cells which can be induced to unite with the actively growing tissues of the inoculated tree. In some cases the disease has a period of incubation extending over two years, and the probabilities are that additional experiments will demonstrate in some cases a still longer period. Many hundred experiments have proved these conclusions to be correct.

(3) The life of inoculated trees varies from one and one-half to four and one-half years. In orchards the death of the entire tree occurs in from one to six years. In a majority of cases the disease is chronic, and some part of the tree may live for a long time.

The experiments with fertilizers were continued during the season. The results confirm in all essential particulars those of previous years. New cases of "yellows" were numerous in the orchards under treatment, and the use of commercial fertilizers exerted no restraining influence. In a few individual cases, under the influence of large doses of potash, phosphoric acid, and nitrogen, the affected trees improved in appearance, but they continued to develop diseased growths and bore premature fruit. The results of these experiments will be arranged for publication at an early date. Other experiments are not ready to be reported upon.

Dr. Smith has this year given considerable attention to peach rosette in Georgia. The result of the last year's inoculations were very gratifying. In one experiment, out of one hundred and twenty-five trees one hundred and twenty-one contracted the disease in less than one year, and most of them within six or eight months, thus establishing beyond dispute the contagious nature of the disease. As in the case of "yellows," the union of a small fragment of diseased tissue was sufficient to induce the disease. Another experiment proved that part of a tree may be healthy and part diseased, and this establishes the fact that the disease is due to something which circulates gradually through the tissues of the tree. Additional experiments, including bacteriological cultures and inoculations, were made during the year, but it is too early to speak positively as to the results. The disease runs a rapid course, and is believed to be nearly or quite as dangerous as peach yellows, although less widely distributed. Growers are advised to root out and burn affected trees as soon as discovered.

THE CALIFORNIA VINE DISEASE.

Since my last report Mr. Newton B. Pierce, the special agent in charge of the California vine disease, has prepared a preliminary report giving the results of his investigations up to the beginning of 1891. In this report he gives a short history of the introduction and spread of the vine in California, showing that for over three hundred and fifty years prior to the appearance of the disease, the grape had been grown in Mexico, Lower and southern California, without any widespread death of the vines. He then traces the development and spread of the disease from Anaheim as a center. It appeared there in 1884, and in two years from that date many thousand vines had died. The characters of the disease as it affects the leaves, canes, and fruit are given, as well as a statement of the effects of various external conditions on the malady. The influence of shade, of climatic conditions, such as rainfall, fogs, and temperature, are fully investigated. An account of the various diseases of the vine is also given, to compare the effects presented by them with the disease in California. There is some little similarity between *Rougeot* as known in Europe and the California disease, but the effects of the two are widely different.

It is too early to state positively the cause of the disease or to make many recommendations as to prevention or cure. It is said, however, that if the vines be kept in good condition they may be able to withstand the attacks of the disease for a longer period. To that end sulphuring is recommended.

After the completion of this preliminary report, which it is hoped may be printed early in the year, Mr. Pierce proceeded to California, where he arrived on July 15. A month was devoted to observation in various parts of the State, the objects being to obtain a personal knowledge of the viticultural and horticultural interests in the northern counties and to ascertain the need for action in relation to plant diseases existing there. It was also desired to review the situation in southern California, preparatory to the selection of some place to continue the study of vine diseases of that region.

The review of Sacramento, Napa, Sonoma, Santa Clara, and San Joaquin valleys has shown that the dreaded vine disease of California is almost wholly confined to the counties of the southern district. The fact that after a period of five or six years the disease has not developed to a serious extent elsewhere should give confidence to those desirous of setting new vineyards in the San Joaquin valley and northward. It also strongly indorses the view that the disease has or will largely spend its force in the counties now affected by it. A review of the interests of fruit-growers and nurserymen in the valleys named reveals the fact that several fungous diseases, and others not due to the action of insects, are present and are of sufficient importance to deserve careful study. Most or all these diseases, however, are likewise present in southern California, and may be studied there to equal advantage.

In southern California observations led to the selection of Santa Ana as the most favorable point for the continued study of the vine disease. More young vineyards are being planted in that portion of the diseased district than elsewhere, and these afford the needed opportunity for experiment and study. Facts obtained in various parts of Orange and Los Angeles counties show beyond question that the disease is still present, and that it not alone continues to kill formerly affected vines, but it is also attacking vines set two years, from healthy-rooted plants.

Its action in older vineyards is still very pronounced. One of the finest vineyards remaining near Florence produced only one-third the amount in 1891 which it had produced in 1890. This was owing to the action of the disease.

Though the disease is present and showing considerable virulence, there are signs of its gradual diminution in force. At present, however, it does not appear that more than a limited planting of vineyards is warranted in Los Angeles and Orange counties. From facts set forth in the preliminary report on diseased cuttings, as well as from more recent observations, it is advised that no cuttings be planted except those procured from districts known beyond question to be free from this malady. No cuttings should be used which have been made in Orange, Los Angeles, or San Bernardino counties, more especially if taken from old vines.

After locating at Santa Ana, steps were taken to fit up a laboratory for bacteriological work. At present somewhat over two months of work has been done on the vine disease. All that can be now said respecting this is that no culture medium tried has led to the isolation and growth of microörganisms in sufficient numbers, or with sufficient constancy, from the diseased vines, to lead to the belief that such organisms could with probability be the inciting cause of the disease. A most thorough investigation along this line is warranted by all observations in the field. These point strongly to a disordered state of the fluids of the vine.

Owing to the fact that certain other plant diseases of California properly falling under the line of work of the Division of Vegetable Pathology are now causing much injury to the fruit interests of this State, it has been thought best to devote some time to their investigation. In pursuance of this plan the cause of a serious disease of almond trees has already been investigated, and this will be followed by experiments in spraying. The rust of the prune is also becoming one of the more serious diseases of the southern coast counties, and arrangements have been made for a series of experiments to be undertaken the coming season.

WORK ON PEAR BLIGHT.

During the year the attention of Mr. Waite, the agent in charge of this subject, has been mainly directed to investigations bearing on the life-history of the pear-blight organism. The obscurity of the subject has rendered many of the experiments fruitless, or they have given merely negative results, but at the same time some new and important facts have been discovered. The work may be divided into two classes, namely, laboratory investigations and field experiments.

In the laboratory the germ has been cultivated on sterilized nutrient media, and its growth has been carefully studied. Cultures for use in field experiments have been made, and the following outline will serve to indicate the results:

(1) In young liquid cultures the germ occurs in long chains of a dozen or more individuals joined end to end. Several of these chains form a tangled mass.

(2) The germ grows but feebly on gelatine prepared from beef or potato broth, although it thrives on these when the gelatine is absent. It does not grow in infusions of the green fruit and young twigs, although these are the portions of the host in which it thrives best as a parasite.

(3) The germs are killed by a temperature of 50° C., the majority succumbing on an exposure to this temperature in water or liquid media for five minutes. They thrive

best from 20° to 22° C., while in the thermostat they reach their maximum development soonest, but are less vigorous at a temperature of 36° to 37° C.

(4) The germs are killed by an exposure for ten minutes to a solution of mercuric chloride of 1 part to 100,000. Under the same conditions a 5 per cent solution of copper sulphate failed to kill them in part of the trials, and a 2½ per cent solution uniformly failed to have any effect.

(5) No spores have been found, after repeated examinations under the microscope. The conclusion seems to be that spores are not formed. The motion of the germ has been proved to be due to the presence of cilia.

The field work consisted principally of inoculation experiments under varied conditions. The most important results were obtained from experiments with the pear flowers and the distribution of the germs by insects. The following is a summary of the results obtained at Washington, and at Brockport, N. Y., at both of which places experiments were made:

(1) Pear flowers infected with the germs, either naturally or artificially, break down with the disease. The germs normally gain an entrance through the tissues of the nectaries. At other points the germs gain an entrance through a puncture or injury to the epidermis.

(2) The germs multiply in the nectar of the flowers, and are carried by insects from one flower to another. Bags of paper, cheese cloth, mosquito netting, or in fact anything keeping the insects out, will preserve the trees from blight.

(3) Certain varieties of pear, the Bartlett among them, failed to set fruit when insects were excluded. Others, such as the Duchess and Seckel, did not need insect aid.

(4) Trees in flower and infected artificially with pear-blight germs may be sprayed and the spread of the disease may thus be prevented; at the same time from 98 per cent to 100 per cent of the infected flowers will be saved. Bordeaux mixture, ammoniacal solution of copper carbonate, and a 3 per cent solution of chloride of lime were used in the experiments.

CITROUS FRUIT DISEASES IN FLORIDA.

Within the past three years numerous complaints have been received from Florida in regard to diseases affecting citrous fruits. With the view of obtaining some definite information as to the nature and extent of these diseases, Mr. Erwin F. Smith and Mr. W. T. Swingle were sent to the State the latter part of June, in accordance with your instructions. Mr. Smith remained only until July 10, but Mr. Swingle stayed until August 15, and completed the circuit of the more important orange-growing regions. Groves were carefully examined and the orange growers interviewed at twenty-six towns in fourteen counties. The growers everywhere showed the greatest interest in the work, and every courtesy was extended to the special agents.

The orange industry of the State represents a large amount of capital. Where the groves are healthy the profits of the business are often very great. It is no uncommon thing for an orange grove from seven to twelve years old and in good bearing to sell at $1,000 to $1,500 per acre. Even uncleared hammock land suitable for orange groves is often sold for $40 to $125 per acre, although the expense of clearing is sometimes nearly equal to that. A single tree in good bearing often pays 10 per cent interest on a value of $50 to $150. The diseases that have recently appeared have seriously hurt many of the finest groves, have affected the value of real estate, and even threaten to destroy the industry in some of the best orange-growing localities.

Of the maladies of citrous fruits the "blight"—also called "leaf curl," "wilt," or "go-back"—is no doubt the most feared and is likely to prove the most destructive. The first sign exhibited by trees attacked by it

is a sudden wilting of the leaves. Often the whole top of the tree is thus affected, and soon dies. Vigorous shoots are then produced from near the ground. These at first seem healthy, but finally also become diseased. After a few years the tree dies entirely. From the first attacks of the blight no fruit is produced. Both the cause and the remedy of this destructive disease are unknown. Year by year it extends to new groves, as well as increases in those in which it has already obtained a foothold, and many of the finest orange regions are badly infected.

Another disease of the orange, known as "foot-rot," causes nearly as much damage as the blight. It is manifested by the bark at the surface of the ground dying in spots. The bark exudes a gum and finally scales off. Gradually new areas of bark are killed and in many cases the tree is girdled. Unlike the blight, this malady causes the tree to fruit heavily until it becomes exhausted and dies. Direct remedies are said to exist, but, as a matter of fact, work unsatisfactorily. The almost universal testimony of orange-growers was that budding on sour orange stock would prevent the disease. Observations confirmed this belief. A reliable remedy that would be able to cure trees already in bearing would be of great value.

A third disease of the orange, known as "die-back," often causes the loss of several crops of fruit or even the death of the tree. The twigs of trees affected by the disease show brownish, resin-like exudations, and do not mature well, but die back several inches. New shoots are produced only to share the same fate. Fruit is rarely matured on such a tree, but cracks and falls off. The center of such fruit is gummy, and the skin shows reddish-brown spots. The cause of this malady seems, at least in some cases, to be improper treatment, and especially the injudicious use of nitrogenous fertilizers. Careful experiments are necessary to decide definitely the cause and remedy of the disease. Trees are said to recover in many cases.

A disease attacking all citrous fruits, known as "sooty-mould," occasionally causes considerable damage. The cause of the disease is a black fungus, which grows luxuriantly on the surface of the leaves. It seems restricted to trees already attacked by certain insects. Its action in some cases prevents the fruiting of the trees. One grower estimates his loss for 1891 from this disease at $500.

Lemons and limes are liable to a curious malady known as "scab," which disfigures and renders the fruit unsalable. Small whitish, wart-like excrescences are formed on the fruit, and the tissues situated beneath such a wart grow rapidly and produce irregularity in the shape of the fruit. When very bad, the excrescences may be so numerous as to dwarf the fruit and even cause its premature fall. In some localities lemon trees have been cut down and budded to oranges because one-third to one-half of the crop was annually lost because of this trouble. In other places the growing of limes had to be discontinued on account of it.

Other diseases occur which are more restricted in distribution and less destructive, but they need to be watched carefully lest they spread and do greater damage. It may be truthfully said that the orange industry of the State is in serious danger, and a careful and thorough investigation by the Department is most urgently needed. Such an investigation in the present condition of the funds at the disposal of the division is not possible, and a larger appropriation is absolutely necessary if proper attention is to be given to the study of these diseases in Florida.

THE GRAPE SCARE IN NEW YORK.

In the latter part of September much excitement was created in New York City by the Board of Health seizing a quantity of grapes which had been sprayed with Bordeaux mixture. All sorts of rumors were rife at the time, columns of sensational matter appearing every day in the leading papers of the city and State. This, of course, seriously injured the grape market, which, for various other reasons, was already considerably depressed. At the request of the New York Board of Trade, and in accordance with your instructions, I went to New York City when the excitement was at its height. It was found that the sensational reports to the effect that tons and tons of grapes were being seized and dumped in the river were wholly without foundation. The Board of Health, acting upon the advice of its assistant chemist, had seized a small consignment of fruit from Ulster County, N. Y., and upon this most of the fabulous stories were based.

Soon after my arrival a meeting of the Board of Trade was called for the purpose of allaying, if possible, the fears of the public and restoring the market to its usual condition. By request I addressed this meeting, and gave a detailed account of the methods employed in treating grape diseases, dwelling particularly on the Bordeaux mixture and its entire harmlessness when properly used. The meeting appointed a committee to confer with the Board of Health on the subject. I was invited to be present at this conference, which took place immediately after the adjournment of the Board of Trade meeting. The committee was received very courteously by the Board of Health, and after some preliminary remarks by the president I was again asked to give an account of the Bordeaux mixture, how it was made and used, what it was used for, etc. This being done, the Board of Health gave its side of the case, which in brief was that their attention had first been called to the matter by a citizen sending in a quantity of grapes plastered with a bluish-green substance. The matter was referred to the assistant in charge, who decided that the bluish-green deposit contained copper in large quantities. Search was then made at the fruit stands, commission houses, boat landings, and other places, the result being in accordance with the facts already set forth. After further deliberation the following statement was prepared by the Board of Health and given to the papers:

(1) A copper salt is found only upon a very small part of the grapes offered for sale, and the grapes which are to be avoided are easily recognized by the greenish-colored substance upon the berries and stems.

(2) Whenever this substance is apparent upon the berries or stems the grapes should be washed before they are used as food or in the manufacture of wine.

(3) The board urges all dealers and consignees in this city to advise shippers and consignors of grapes to send no more grapes to this market upon which this substance is apparent. The board further states that it does not object to the use, at the proper time, of the "Bordeaux mixture" as recommended by proper authorities, but such mixture, or any mixture containing poisonous substances should not be sprayed or otherwise placed upon the grapes immediately before or after they have matured, and should not appear upon them when sent to the market or offered for sale.

For the purpose of inspecting the vineyards the Board of Health, before finally adjourning, decided to send the assistant chemist to the region from which the seized fruit came. In accordance with your wishes, the division was also represented at this inspection, Mr. D. G. Fairchild being selected for the purpose. No facts of importance were brought out by the visit of the assistant chemist and Mr. Fairchild,

excepting that wherever vines had been sprayed in accordance with the precautions so many times set forth by the division the fruit was in excellent condition, both as regards freedom from rot and the objectionable deposit. After this nothing further was heard of the matter, and in a week at most the market was in about its usual condition.

A large mass of facts has been collected bearing on this question, all of which will be given in the bulletin on the work of the season. Looking at the matter from all sides, no conclusion can be reached other than that the blame for the "scare" and its consequences rests about equally between the Board of Health and a few overzealous grape-growers. There is no doubt that some growers exercise gross carelessness in unnecessarily daubing their fruit with the mixture long after the treatments should have ceased. Even when it came to send the grapes to market, they were in some cases seemingly dumped into the baskets without the slightest effort being made to remove the bluish deposit, which was in no case found on berries properly treated. Only a few growers did this, but thousands were made to suffer thereby. On the other hand, the Board of Health acted hastily in the matter, and by its method of conducting affairs caused the press to make a mountain out of a molehill. Altogether the lesson has been a valuable one, and it again forcibly illustrates the old saying that even the best of remedies in the hands of some will often prove a curse. In some parts of the country grape-growers were actually spraying their vines two and three times a week, thinking, as some of them have stated to me, that if twice a month was good, four or five times as often would be a great deal better.

In this connection it may be well to caution all grape-growers in regard to the use of Bordeaux mixture in seasons of drought. In case dry weather sets in after the first or second spraying, it would be well to make the rest of the treatment with the ammoniacal solution of copper carbonate. Altogether, this course of treatment will probably be just as effective against rot and other diseases, no matter what the season may be. It is certainly cheaper, and removes at once all probability of disfiguring the fruit. It should be borne in mind, however, that the application of all fungicides should cease as soon as the fruit begins to ripen. If this be done, not the least damage to health need be apprehended from eating the fruit or drinking the wine made from the same. In fact, as has already been shown in the publications of the division, such fruit and such wine actually contains no more copper, which is the only poison to be considered, than many other foods we eat.

The following is an abstract of a paper giving some of the results of an investigation conducted under the auspices of the division by Dr. B. D. Halsted and Mr. D. G. Fairchild. It is published in full in the Journal of Mycology, Vol. VII, No. 1 (pp. 1–11, Plates I–III). An experiment is now in progress to determine the effect of fungicides in preventing the disease.

SWEET-POTATO BLACK ROT.

Ceratocystis fimbriata, Ell. & Hals.

(Plates I, II, and III.)

The black rot of sweet potatoes is considered by farmers the most destructive of all the diseases of this staple crop. The losses from it often amount to from 20 to 25 per cent of the yield, and so far as known no region where sweet potatoes are grown is free from it. Perhaps the chief danger occurs after the potatoes have been stored in bins for the

winter, for the presence of rotted roots here causes a rapid spread of the disease through the bin. The "black shank" of sprouts in the hotbed is a second form of the disease, and the wholesale destruction of young sprouts often occasions considerable loss and much additional labor in the spring planting.

The characteristics of the disease are the presence upon the potatoes or the young sprouts of dark, olive-brown, or green patches, generally penetrating the tissue. These dark areas increase in size until they cover the whole potato, or cause death of the sprout by girdling.

The cause of the disease is a minute fungus, which lives in the starchy tissue of the root or grows through the soft stems of the shoot in the hotbed. When the dark areas characteristic of the disease are examined minutely they are found to consist of dead or dying tissue filled with the innumerable threads or vegetating portions of the parasite, and these, on account of their greenish color, give an olive-green shade to freshly cut diseased portions.

By means of cultures it has been ascertained that the fungus which causes the disease has several distinct forms of reproductive bodies. These are shown on Plates II and III. In two of these forms the spores are borne on the ends of creeping or upright threads. In the third they are produced in the interior of globular bodies, which are embedded in the tissue, and which have long, slender, hollow necks projecting above the surface of the potato. These interiorly formed spores reach the outside of the potato by being forced out through the hollow neck, whence they are washed into the soil by the rain. The spores, when sown on healthy potatoes, are capable of producing the characteristic dark spots of the disease, and it appears that at least two kinds of spores are capable of retaining their vitality for a number of months. In all probability this makes it possible for the parasite to live from one year to the next in the soil of the potato field.

From a study of the habits of the fungus, the following precautions for its prevention are recommended for trial: (1) Only perfectly healthy seed-potatoes should be planted in the hotbed; (2) none but healthy sprouts should be transferred from the hotbed to the field; (3) if possible, fields infested with the fungus should be planted with some crop other than a root crop; (4) the small potatoes and other root débris should be removed from the field after digging; (5) the use of large quantites of hog manure should be avoided, as this seems to favor the growth of the fungus.

DESCRIPTION OF PLATES.

PLATE I, *Ceratocystis fimbriata*, Ell. & Hals.

Fig. 1. Sweet potato showing blackened area, inhabited by the parasite.

2. Cross section of the same.

PLATE II, *Ceratocystis fimbriata*, Ell. & Hals.

Fig. 1. Sporophore of hyaline conidia figured 1 p. m. *1a*, the same figured 1:50 p. m. *1b*, the same at 2:15 p. m. × 550. From test-tube cultures of sweet potato agar-agar.

2. Group of hyaline conidia, showing variations in form from test-tube culture. *2a*, the same from plate culture × 400.

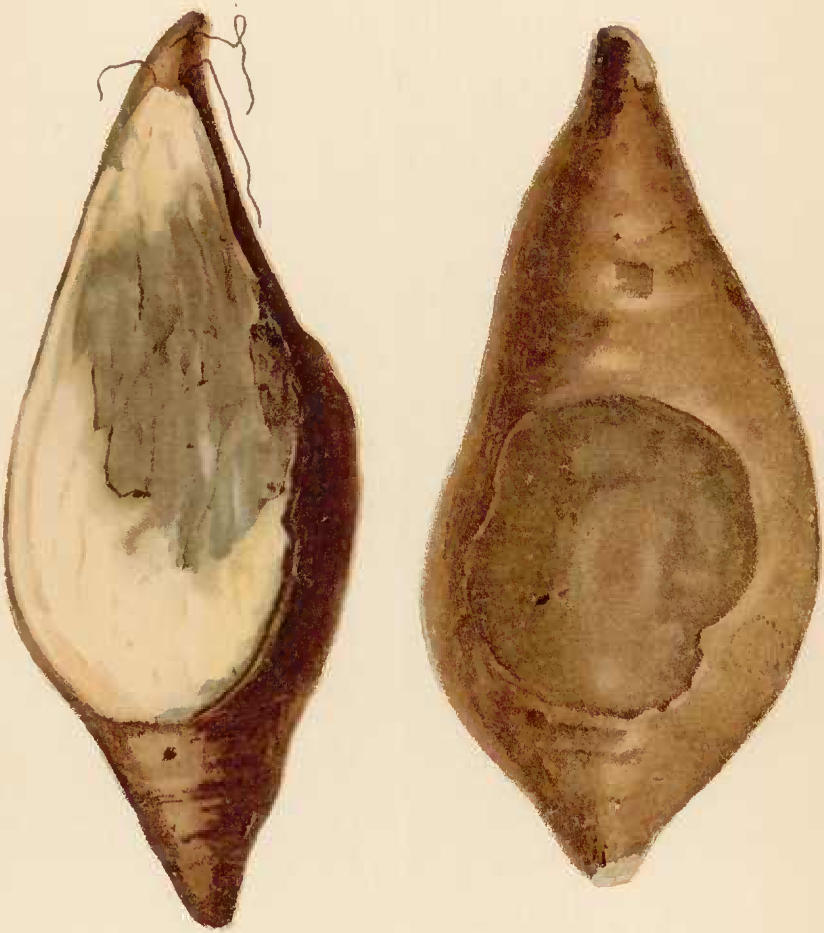
3. Group of hyaline conidia sporophores, showing spore formation × 300. From test-tube cultures.

4. Germinating hyaline conidia from cultures 24–48 hours old in sweet-potato agar. *4a*, young germ hypha with hyaline conidium forming. *4b*, hyaline conidium lately expelled from sporophore. *4c*, commencement of sporophore or branch of hypha of germination × 550.

5. Sporophores with olive conidia issuing from tips. 5*a*, characteristic primary spore first formed × 550.
6. Sporophore of olive conidium greatly enlarged × 1,500. 6*a*, ruptured outer wall of sporophore. 6*b*, protoplasmic contents of mother cell.
7. Olive conidia germinating × 550.
8. Successive stages in formation of olive conidia. 8*a*, sporophore and spore figured 12:15 p. m. 8*b*, same 2 p. m. 8*c*, same 4:35 p. m. 8*d*, same 6:25 p. m. 8*e*, 9 a. m.
9. Primary growth of mycelial hyphæ from hyaline conidium.

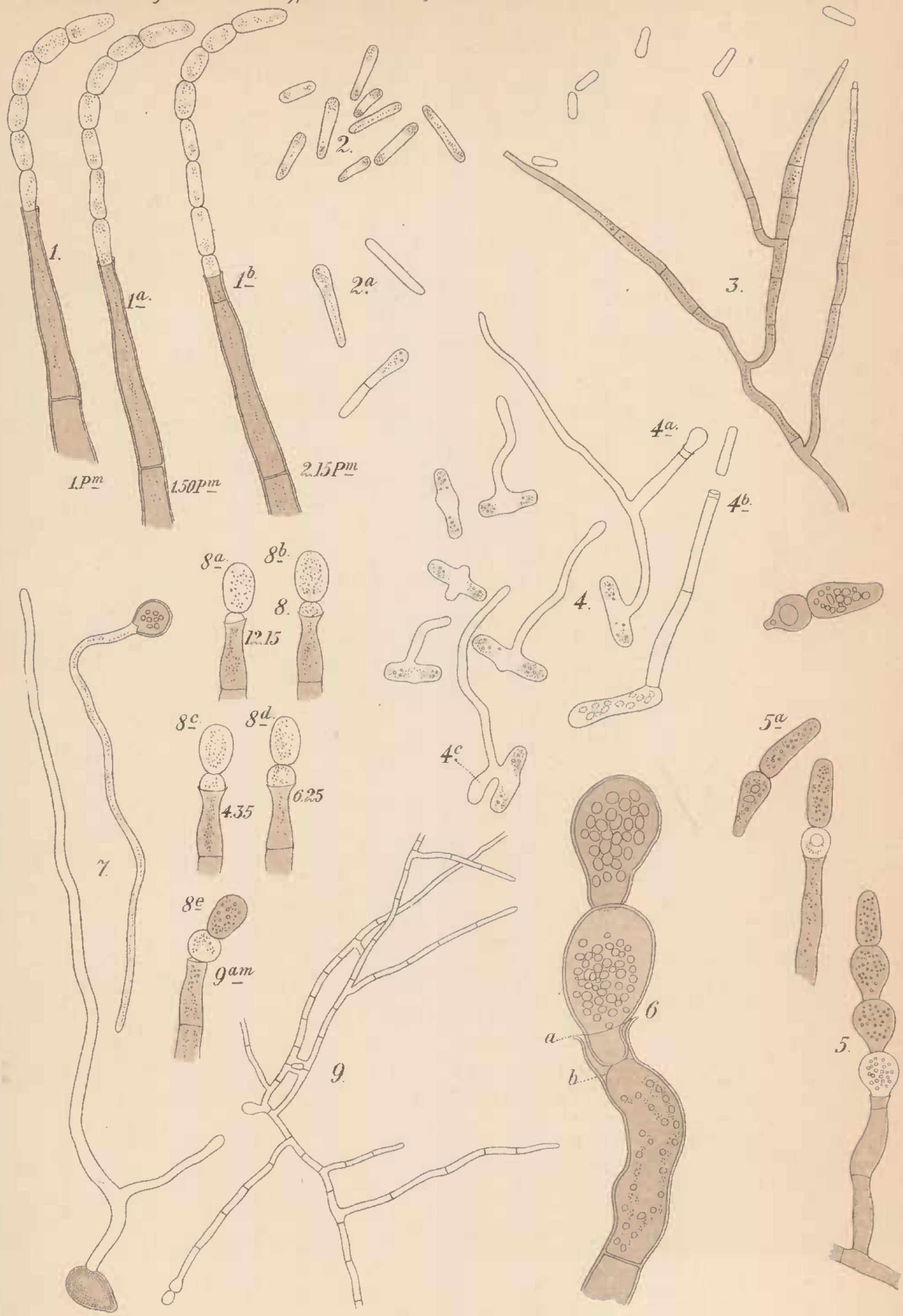
PLATE III, *Ceratocystis fimbriata*, Ell. & Hals.

Fig. 1. Mature pycnidium × 200. 1*a*, gelatinous mass of exuded spores.
2. Fimbriate tip of beak or ostiolium × 500.
3. Cross section of pycnidium showing large thin walled cells, previous to spore formation × 300.
4. Gelatinous mass of pycynospores × 550. 4*a*, isolated spores shortly after immersion in iodine. 4*b*, pycnospore after 48 hours in sweet-potato agar culture. *N*, nucleus; *G*, ring of gelatinous granules.
5. Cross section of pycnidium beak near base × 550.
6. Primary growth of mycelial hyphæ from pycnospore × 200.
7. *a*, Anastomosing hyphæ abundant on mycelium from pycnospores and hyaline conidia × 440.
8. Germinating pycnospores. 8*a*, ring of gelatinous uniting substance. 8*b*, promycelium in form of a sporophore with hyaline conidium issuing × 550.
9. Primary stage in development of pycnidium × 550.
10. Early stage in development of pycnidium × 550.
11. Immature pycnidium × 400.



BLACK ROT OF SWEET POTATO.
(Ceratocystis fimbriata, Ell. and Hals.)

Sackett & Wilhelms Lithographing Co. New York

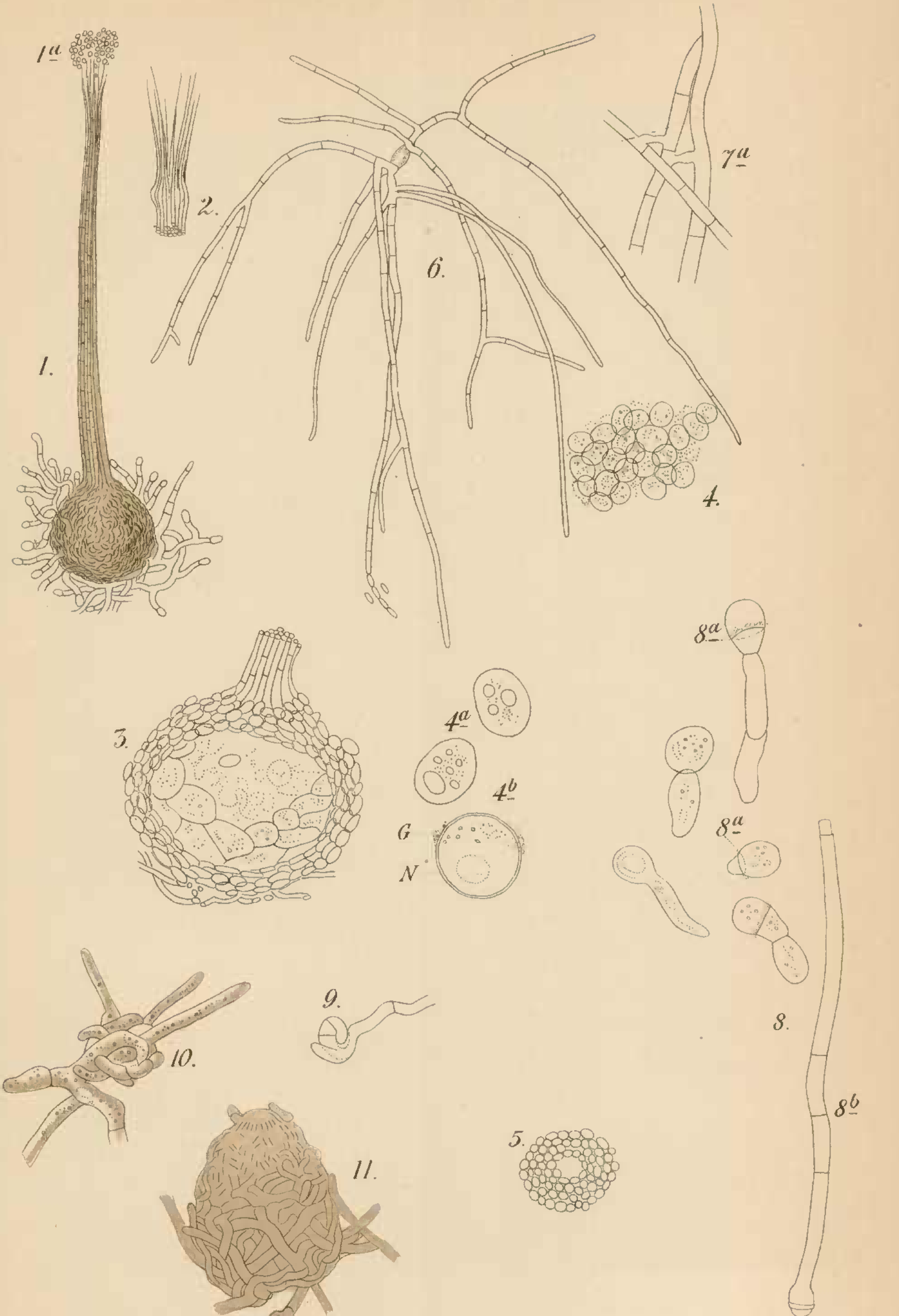


Black Rot of Sweet Potato.

(Ceratocystis fimbriata, Ell. and Hals.)

D. G. F. del.

Sackett & Wilhelms Lithographing Co. New York.



BLACK ROT OF SWEET POTATO.
(Ceratocystis fimbriata, Ell. and Hals.)

D. G. F. del.

Sackett & Wilhelms Lithographing Co. New York.

REPORT OF THE POMOLOGIST.

SIR: I have the honor to submit herewith my sixth annual report as Pomologist of this Department.

During the past year two clerks have been added to the force of this division, and Mr. W. A. Taylor, of Michigan, has been appointed assistant pomologist in place of Mr. C. L. Hopkins, of Florida, who resigned on account of ill health. With this increase in the office force it has been possible to enlarge materially the work of this division, but not to keep fully up to the work which is now in progress or to develop new lines which are contemplated. The work of tabulating and preparing for publication the reports of over 5,000 correspondents occupies much time and requires great skill in the subjects treated; but I may be allowed to state that all employees of the division seem specially fitted for their duties in this line, and are willing to do extra work, whenever it is necessary, outside of office hours. I would respectfully urge the necessity of further enlarging the force of this division

Permit me to urge the need of additional special agents also. During the past year only one has been regularly employed by this division, and three commissioned for periods of from one to six months. For the demands of so important and widespread an industry as fruit-growing, these are far from adequate.

Very respectfully,

H. E. VAN DEMAN,
Pomologist.

Hon. J. M. RUSK,
Secretary.

THE FRUIT CROP OF THE YEAR.

The fruit crop of the year 1891 was remarkably large. Apples have not only been very abundant, but owing to the scarcity last year of fruit in which insects breed, and to the increased use of insecticides and fungicides, they have been unusually free from the depredations of insects and fungous diseases.

Peaches have also been very abundant over nearly the whole of the peach-growing regions. In Connecticut a late frost cut off almost the entire crop when in bloom, and the same thing occurred in some portions of North Carolina, Georgia, and Ohio and in the southern counties of the Chesapeake peninsula, which has long been considered the most important of all the peach-producing sections. Furthermore, in the northern counties of this peninsula the yellows made sad havoc late in the season, when it was thought that a crop of over 8,000,000 bushels was secure. The fruit ripened prematurely, and in many orchards

where thousands of bushels hung on the trees not a peach was gathered. From this district less than 4,000,000 bushels were sent to market. In the famous peach region of Michigan, especially in Berrien, Van Buren, Allegan, Oceana, and Benzie counties, a large crop was gathered, and the yellows did but little damage, owing to the rigid enforcement of a wise State law that requires the destruction by fire of all diseased peach trees as soon as discovered. Where formerly this dread malady ran riot in Berrien County, Mich., there is now rarely a sign of it, and the peach industry is again becoming profitable.

The pear crop was so large in some of the central States that there was barely a market for the supply. In Massachusetts, New York, Pennsylvania, Missouri, and California the crop was heaviest. In the South, where the Le Conte has proven so profitable, the "fire blight" has been making inroads, and there is danger that this variety, which for a time was thought to be exempt from the disease, may yet prove to be equally subject to it with other kinds.

The plum, both the native and the foreign, has also borne well. The variety known as Wild Goose was in every market during the early part of the season, and California soon flooded the East with the large foreign varieties. Kelsey, the largest of the Japanese plums, was noticed on the fruit stands, having been shipped from California and Florida. It may be shipped with little damage, owing to its firm flesh. Specimens from Ocean Springs, Miss., measured 3 inches in diameter. New York had the heaviest plum crop for many years. The States of Washington and Oregon take the lead in the production of plums of large size and excellent flavor. Specimens of 2, and even 3, inches in diameter are not uncommon in the eastern parts of those States.

Grapes have also been abundant; from Maine to Florida and from the Atlantic to the Pacific the crop has, with a few local exceptions, been heavy. The valleys of Utah, Arizona, and New Mexico and the southern parts of Texas and Florida are beginning to produce the same kinds that are grown in California—muscats, Tokays, etc.—and may be expected to compete soon with that State. Western and central New York produced immense quantities of such varieties as the Concord, Worden, Delaware, Niagara, and Catawba. Northern Ohio sent to market a large crop of Catawba, Delaware, and other kinds. Florida is becoming known as being earliest in the grape market, and Texas, Georgia, and the Carolinas next. There is now no gap in the grape market from June until spring, for the later kinds are easily kept all winter in the cold-storage houses. Good grapes have sold at retail in many of the large cities for less than 2 cents per pound.

The orange crop was not so large as was expected, owing to sharp frosts in Florida and California, but there was a liberal supply. The exportation of this fruit to England has begun, and a line of steamers between Jacksonville, Fla., and Liverpool is being established to carry the freight. Mexico, on the other hand, has begun to ship oranges to this country, and our growers may therefore look for competition from this direction.

Another citrus fruit that is becoming quite popular is the pomelo. Hitherto its cultivation has been almost wholly confined to Florida, but California is now trying it. Specimens received from Oroville were of fair quality, but in competition with that produced in Florida this fruit is likely to be at a disadvantage because of its thicker peel and more acid flavor. These objections are sometimes made even to the Florida fruit, though it is very wholesome and, to most persons, of agreeable flavor. The market demand is steadily increasing, and seed-

ling varieties are being named and large orchards of budded trees are being set in Florida. It is to be regretted that the names "grape fruit" and "shaddock" are applied to the pomelo, as they are neither appropriate nor absolutely correct.

Of the small fruits, the strawberry was abundant in all sections, and prices ranged low except for very choice lots. The same is true of the blackberry, raspberry, gooseberry, and currant. In some localities frost, insects, and fungous diseases worked slight damage. The cranberry crop has, on the whole, been quite good, especially in the New England States and in New Jersey, where favorable conditions increased the crop about 17 per cent above that of last year. In the West damaging frosts occurred in the spring, and also in July, August, and September, which caused a decrease from last year's crop of 83 per cent. According to the statement of the American Cranberry Growers' Association, the crop in the United States this year has been 702,250 bushels, against 800,000 last year.

Nut trees of all kinds bore a heavy crop. As a rule, the wild walnuts and hickories bear full crops only on alternate years. Last year there were very few and this year there have been many. Our native nuts are rarely found in cultivation, but the interest in nut culture is growing, and especially in the pecan, which is probably the best of all nuts, either native or foreign, which are found in our markets. The improved varieties of this nut were mentioned in my report of last year. In California there is a lively interest in the culture of the Persian walnut. This nut has often been incorrectly called "English walnut" and "Madeira nut," but recent investigations prove the name "Persian" to be the correct one. All over the country there is a slight interest in the culture of foreign chestnuts, but there is great need of more extensive plantings. Our markets are poorly supplied, and the price is therefore high for these and other nuts which should become a common article of food here as in southern Europe. Already a much larger import trade is carried on than our farmers should permit, and we trust that the tide of trade in nuts will in time be turned the other way, as is now the case with raisins, oranges, and canned fruits.

FRUIT-FARMING IN SOUTHERN MISSOURI.

In the middle of August I had the privilege of personally examining the southern part of Missouri with reference to its capabilities for producing fruit. Special attention was given to the Olden fruit farm in Howell County. The berry crops were all harvested before my arrival, but the fields of thrifty plants and records of market returns gave evidence of a large yield of strawberries, raspberries, and blackberries. I have never seen more healthy and vigorous plants of these fruits. While it is not the purpose of the management to grow berries except as a means of furnishing steady employment to the farm hands, there is a good profit in their culture. A cannery has been built on the farm, and when there was little profit in shipping the fresh fruit to market, which is principally Kansas City, Mo., and Memphis, Tenn., it was canned at home and sent to market as occasion required. The Hopkins has here proved the best of the black raspberries, as it is not only very early but exceedingly productive. Among blackberries the Snyder, Taylor, and Ancient Briton have given better returns at Olden than all others.

A few acres are set to pears, and although the trees are young and

consequently small and the blight had made inroads, there was a fair crop. Bartlett had paid the best.

There are now about 500 acres set to apples, and the trees being only from one to six years old the crop was light, but many of them were loaded with large and handsome fruit. Ben Davis is the favorite market variety, but Jonathan and Minkler are also highly prized.

The chief crop at Olden this year consisted of peaches. At the time of my visit (August 14) about 25,000 bushels had been gathered, and there were about 25,000 bushels yet on the trees. There were nearly 400 acres in bearing. It has rarely been my privilege to see specimens so large and handsome or to taste any so richly flavored as those produced here. The whole crop averaged remarkably high in all these characteristics. There were scarcely any culls or second-grade fruit, owing partly to a thorough thinning when the fruit was about half grown. The quality was also improved by this method. The price obtained was 50 cents per bushel for everything sound and over 1¼ inches in diameter, delivered in half-bushel picking-baskets at the packing shed. This practically included the entire crop, for only a few chance seedlings and windfalls were excluded. These and any that were too soft to ship were saved by the cannery, which stands within a few rods of the packing house and near the railway station on the farm. The seeds of such were also saved and the parings fed to the hogs, so that really nothing was lost. Enough picking-baskets were on hand to allow packing to be done directly from them without delay or rehandling. The very early varieties, such as Amsden and Alexander, had been planted in a small way only, and that by mistake, and were not gathered, as they were considered too poor either to send to market or to can.

The St. John was the first to go to market, and Mountain Rose soon followed. Family Favorite was one of the next to ripen, and gave most satisfactory returns. The Mrs. Brett and Susquehanna were handsome and of good quality, but were scant producers and not considered worthy except for amateur cultivation. Elberta was in full bearing during my visit, and in every respect stood about best. It is rather above medium in size, oval in shape, of a rich lemon-yellow, with enough blush to make it showy, and is of most excellent flavor. It bears well and ships well. Altogether, no peach before the public has more good points and scarcely any other is so thoroughly reliable in almost every way. The illustration on Plate I shows a characteristic tree of this variety as grown at this place.

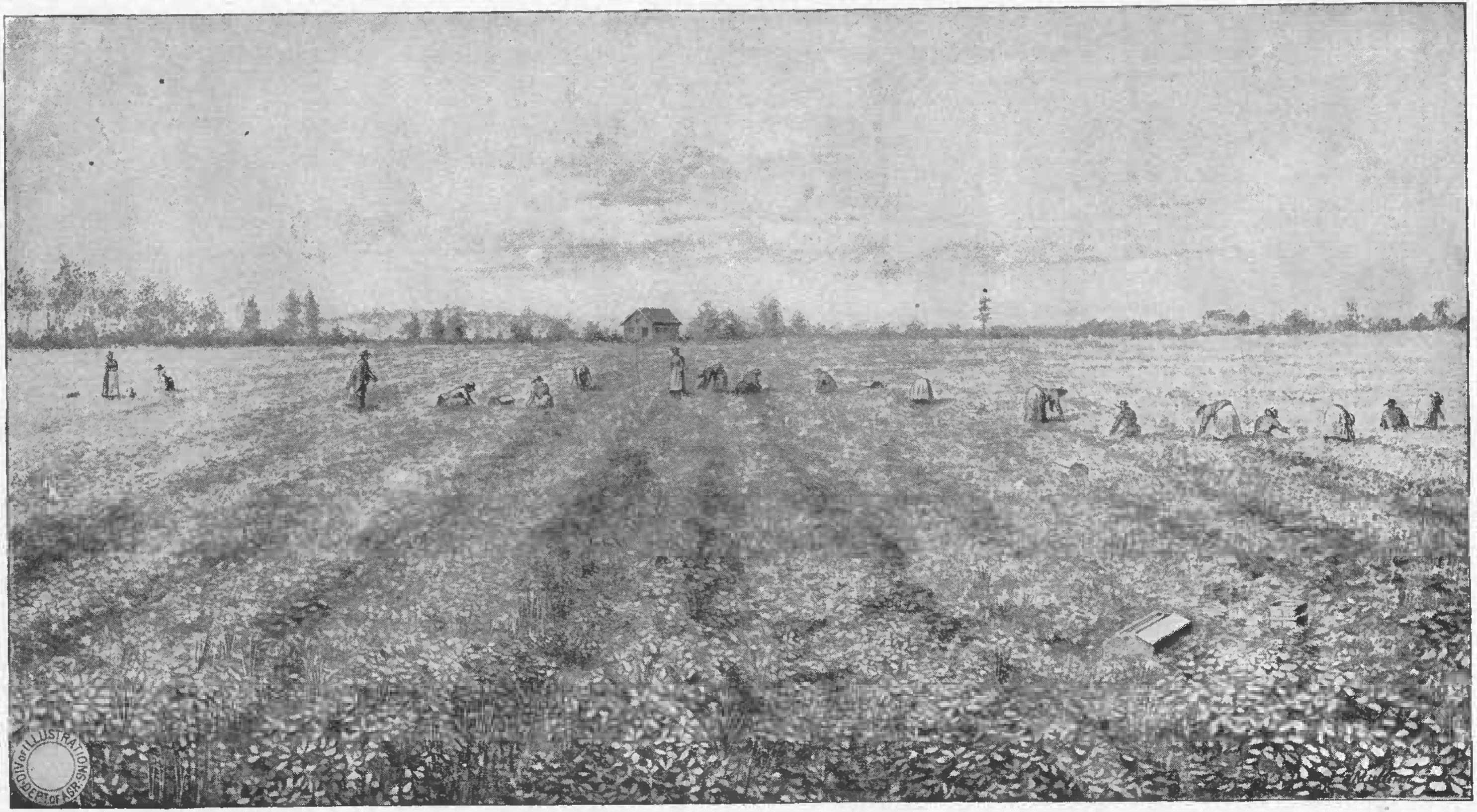
Another of the very profitable varieties is Gold Dust, a yellow cling of medium size, round and regular in shape, and very firm in flesh. The color is very attractive, being dark yellow with a very red cheek. It bears heavily and carries to market with very little damage. Coming as it does before the main peach crop is gathered, it is about the first yellow cling of any special value, and therefore finds a ready sale. Each year it gains in favor, but as it is a variety having but recently originated at Kansas City, Mo., and rarely planted elsewhere than at Olden, the public know little of it. Oldmixon Free and Bonanza are two of the very best of the white and red free-stones, and are largely grown at Olden. Henrietta, Salway, Columbia, and Wilkins were also extensively planted; but, being late, they were not in condition to be examined except as to their productiveness, and in this respect they were up to the standard. Wilkins is a white cling, which is equal to the old favorite Heath cling in quality, and larger, and which after years of trial has practically supplanted that variety. Peach-growing at Olden is cer-

SIX-YEAR-OLD ELBERTA PEACH TREE, OLDEN, MISSOURI, AUGUST, 1891.

PLATE II.

Report of Pomologist, U. S. Department of Agriculture, 1891.

STRAWBERRIES PLANTED BETWEEN POTATO ROWS, PORTSMOUTH, VIRGINIA, MAY, 1891.



STRAWBERRY FIELD NEAR NORFOLK, VIRGINIA, PICKING SEASON, MAY 15, 1891.

tainly a success, and other large orchards are being planted in southern Missouri. The main advantages are cheap land that is of sufficient fertility, a climate usually exempt from damaging frosts, cheap, reliable labor, and along the railroads good facilities for sending the crop to market either fresh, evaporated, or canned.

STRAWBERRY CULTURE IN EASTERN VIRGINIA.

There being large interests in strawberry culture in the tide-water section of eastern Virginia, my assistant, Mr. W. A. Taylor, was sent to visit the farms near Norfolk and Portsmouth the second week in May. In most of the strawberry-growing districts of the United States other fruits also are grown for shipment. About Norfolk no other fruit than the strawberry is grown in any quantity, as the climatic and soil conditions are not favorable to general fruit-growing. The principal business is the growing of truck crops; mainly potatoes, cabbage, kale, spinach, etc.

The method of strawberry culture followed here is such as will best fit into a general system of double cropping, where commercial fertilizers are the main dependence of the trucker to keep up the fertility of the soil. The soil of the region is a shallow, sandy loam, underlaid with clay. It was originally covered with a thick growth of small pine. It is naturally warm, moist, and easily drained, though very flat and only a few feet above sea level.

The method followed by most northern strawberry-growers requires the exclusive use of the land for one full year before the first crop of fruit is secured. This requires a considerable outlay for labor in cultivation and hoeing, for which there is no immediate return. In such a climate as that of tide-water Virginia, where winter is but cloudy and rainy weather, interspersed with light snowfall and only occasional frosts, the cost of the cultivation and hoeing necessary for the narrow rows and clean culture of the Northern method is even greater than at the North. Late frosts in spring, which frequently destroy at least the early bloom (owing to distance from market only the early fruit is profitable), would thus cause the loss of the labor and money expended during the previous year and increase the risk in a line of fruit-growing that is at its best quite hazardous.

These causes, in connection with the experience of the truckers in growing and handling other perishable crops to meet the Northern demand for garden products out of season, explain the reason for the development of the system of strawberry culture now followed by leading growers near Norfolk.

THE NORFOLK METHOD.

Strawberry plants are set out in April, in rows midway between the rows of growing potatoes, cabbage, or other truck crops. The rows are commonly 4 to 6 feet apart, with plants 18 to 24 inches apart in the row. The surplus of fertilizer applied to the truck crop is commonly sufficient to give a luxuriant growth of foliage and runners. Plate II shows a field a few weeks after planting. The cultivation and hoeing of the former, if the soil is reasonably free from seeds of noxious weeds, leaves very little labor necessary in the strawberry rows previous to the harvesting of the truck crop. This, in the case of potatoes and cabbage, occurs during May and June. Cultivation of the straw-

berries is then kept up until midsummer, the cultivator being gradually narrowed as the rows widen by the rooting of runners. Runners are never cut off nor torn up, so that by the time cultivation ceases the rows are matted beds of plants and often 4 or 5 feet in width. After cultivation ceases a growth of grass and weeds springs up. This is cut down with the mower and left for a mulch. Sometimes, when it consists of "crab-grass," this is raked off and used for hay, though cleaner fruit is secured by leaving it to cover the ground and prevent the fruit from being beaten into the sand. Early in the spring, before the opening of the blossoms, a dressing of "strawberry guano" containing about 4 per cent of ammonia and 5 to 6 per cent of potash is often applied. This is sowed broadcast and left for the rains to wash into the soil. Spring cultivation is not practiced.

The aim of the grower is to secure early, clean, and firm berries that will stand shipment to distant markets. It is claimed by the growers that the matted row yields earlier and firmer fruit, and the berries are certainly cleaner than those grown by the narrow row or hill system, unless great care is taken in mulching.

Commonly only one crop of berries is taken, the fields being plowed as soon as the berries are off and a crop of corn or millet secured the same season, or else they are fitted for the planting of a fall crop, as kale or cabbage.

VARIETIES.

After a test of all the early ripening varieties, the Hoffman has been selected as the one best suited to the Norfolk and Portsmouth growers. Probably 90 per cent of the entire strawberry acreage of the region in 1891 was planted to this variety. One 80-acre field was visited that contained no other, and in many fields of 20, 40, or 60 acres the same condition exists. Every early berry that is introduced is tested, the two leading new ones fruiting this year being Westbrook and Michel. Neither of these promises to take the place of Hoffman. The chief points of excellence in Hoffman are the earliness, firmness, and good color of its fruit, combined with a vigorous plant, holding the fruit up well on strong trusses. Its defects are poor quality as a dessert fruit and only moderate productiveness.

MARKETING.

When the picking season arrives, men, women, and children, mainly negroes, come from all the country round and from cities as distant as Richmond and Washington. Two cents a quart is the price for picking, and at this rate the pickers earn from 60 cents to $1.25 per day. Payment is made by means of tickets, which are cashed at stated times. Hand-carriers made with board ends, and with bottom, top, and one side of veneer, the other side being left open for taking out and putting in the quart baskets, are used by the pickers to carry the fruit from the field to the packing-shed, located conveniently near. This carrier holds 6 baskets, is light and strong, and protects the picked fruit from sun and light showers, a point often overlooked by Northern berry-growers. Plate III is from a photograph of one portion of an 80-acre field of Hoffman, on the farm of T. R. Ballentine, Norfolk, Va.

The shipping season begins about May 1 and continues till May 15 or 20. Fruit is often found on the plants later than this, but after the early berries are ripe near the Northern cities shipments from Norfolk cease to be profitable. The shipping case in most common use is the "return" crate, with hinge top, holding 60 quart-baskets packed in four

layers. These layers are separated by slat-strengthened veneer division boards that prevent the injuring of the fruit and insure good ventilation. A 32-quart "gift" crate finds favor with some shippers, and the demand for this style of package seems to be increasing.

Transportation, both by water and rail, to Washington, Baltimore, Philadelphia, New York, and Boston is convenient, speedy, and cheap. No attempt is made to cool the fruit in transit. The water rate to New York this season did not exceed 1 cent per quart. Sales varied from 6 to 14 cents per quart wholesale in the Northern cities for the bulk of the crop, and netted the producers about two-thirds of the wholesale price. The average yield per acre, as estimated by leading growers, is about 2,000 quarts, and at the prices obtained this year the strawberry crop is profitable.

The method practiced by the truckers is probably the safest and most profitable one for them, as it lessens the amount of capital invested in an uncertain crop and gives the early and clean fruit needed to secure good prices when Norfolk berries are in the market. A modification of this method may be found profitable in other sections of the country, where the rainfall is sufficient to carry two growing crops during a portion of the season.

SPECIAL INVESTIGATION OF THE KAKI IN GEORGIA AND FLORIDA.

Early in the autumn of 1891 Mr. William R. King, special agent of the Division of Pomology, was directed to visit a number of kaki-growers in Florida and Georgia for the purpose of furthering the effort to settle the nomenclature of the varieties of this valuable fruit. For years past, both in Japan and in this country, the confusion of names applied to this fruit has been a matter of serious annoyance to cultivators, and has greatly interfered with the cultivation of the kaki on a commercial scale. Thousands of trees have been imported from Japan bearing the names of the best established varieties there, but in many instances they have proved almost as variable as seedlings. In some cases it would appear that the Japanese do not discriminate between the original variety and seedlings that closely resemble it; and this is particularly noticeable in the varieties named Yemon and Zengi, two of the most common in cultivation. In fact, the experience of the past six years, during which this division has been studying the varieties of the kaki, leads us to believe that the only way to render the nomenclature satisfactory is for our nurserymen and principal growers to unite with us in a persistent effort to carefully study and sift the whole subject, and to propagate only from trees which have fruited on their own grounds and have been positively identified by the Pomologist, or by others who have given this subject special attention.

In this connection, also, it must be noted that, in the Southern States at least, the kaki is much more thrifty and vigorous on seedlings of the wild persimmon (*Diospyros Virginiana*) than upon Japanese roots. An erroneous impression on this point obtains with many, owing to the practice of certain nurserymen of using old field root-sprouts for stocks, in apparent ignorance of the fact that they are less thrifty and productive than seedlings, besides being predisposed to harbor the eggs and larvæ of the root-sawyer, which is one of the principal enemies of the persimmon. Methods of propagation vary widely, although the general practice is to graft just at the surface of the ground and draw earth high

up over the juncture. Mr. J. R. McIrvin, of Gainesville, Fla., who has been very successful as a propagator, prefers to dig up, root-graft, and callus, almost precisely as in root-grafting the apple, while in central and southern Florida dormant budding is the favorite method.

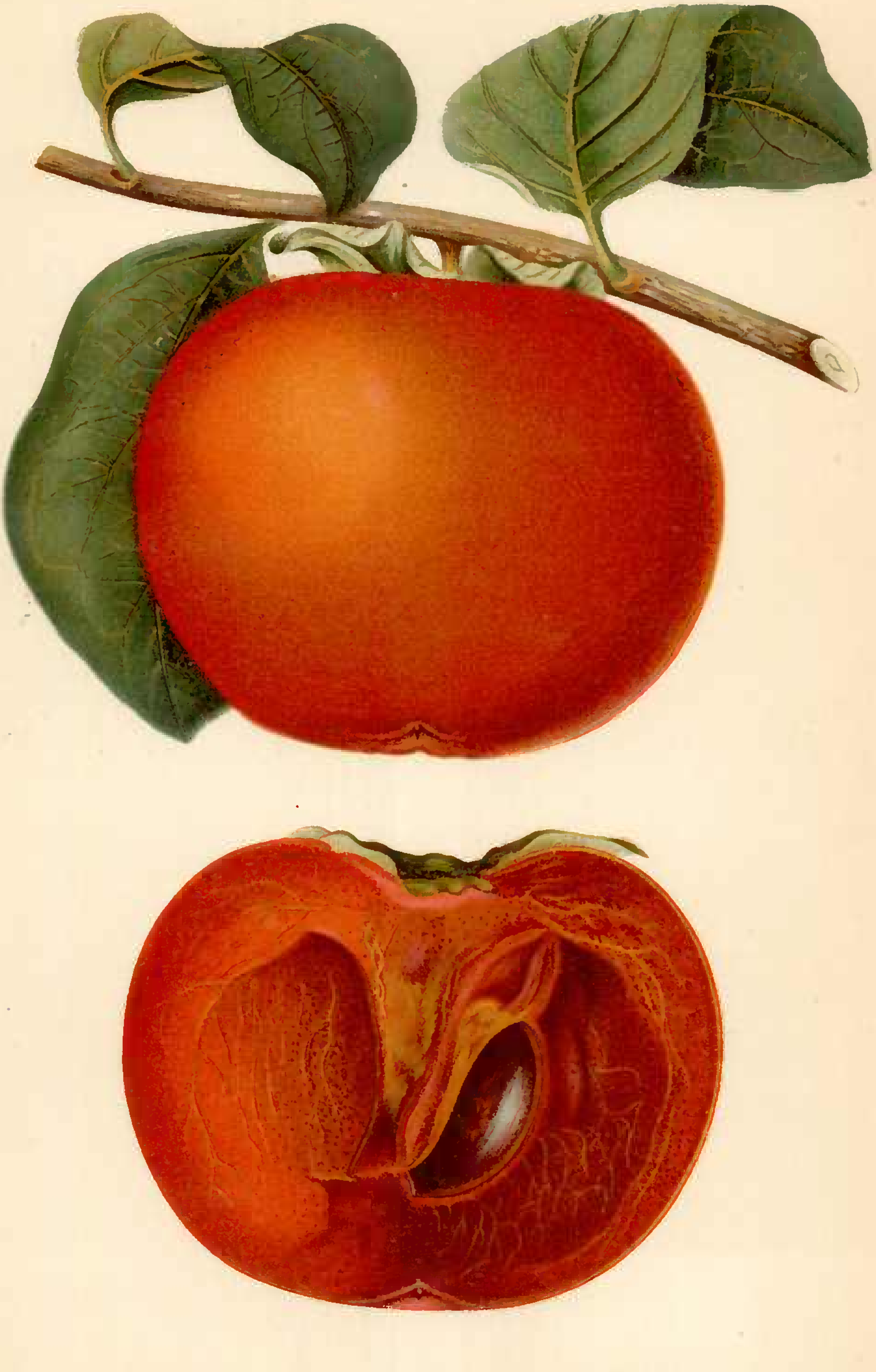
As a direct result of the past season's investigation, we can recommend for general market purposes in Florida and eastern Georgia the following varieties: Tane Nashi and Yemon, described and figured in my annual report for 1887; Hyakume and Yedo Ichi, described and figured in my annual report for 1889; and Kurokuma, as grown by J. R. McIrvin, Gainesville, Fla., and P. J. Berckmans, Augusta, Ga. This fruit is yet comparatively little known in the markets. The dark-fleshed varieties, Hyakume and Yedo Ichi, promise best, being thrifty and prolific, good shippers, and entirely without astringency even when unripe, a point which should weigh much with growers until the consumer is educated to allow the kaki to become perfectly ripe and soft before eating. Tane Nashi is perhaps destined to be the leading variety, being exceedingly prolific, the fruit seedless, regular in shape, and of large size, and the tree of excellent habit and quite hardy, especially where not cultivated too highly; but until better known it should not be planted too freely.

The range of successful cultivation in the Gulf States is now fairly defined for the varieties positively identified, extending from Key West, where at least one tree is growing thriftily, to Augusta, Ga., and into the Carolinas near the coast. As far south as Manatee, Fla., it succeeds admirably on native stock, and is cultivated as a special fruit all through central Florida; but in the northern belt of counties, beginning with the extreme limit of orange culture, it is most at home, although trees have been injured by frost where an early season has induced too free growth. At Waycross, Ga., the tree is apparently as hardy as at Lawtey, Fla., but in the vicinity of Quitman, Thomasville, and Smithville, in southwest Georgia, hardly a tree is now left standing, after many years' trial; while at the nurseries of P. J. Berckmans, near Augusta, Ga., the kaki has proved perfectly hardy, possibly owing to intelligent care and the high gravelly location, far above the Savannah River.

It may be said that our growers and the Department are now practically united on the identity of the following varieties: Hachiya, Tane Nashi, Yemon, Hyakume, Yedo Ichi, Tsuru, Zengi, Kurokuma, Yama-tsuru, and Dai-dai. Hachiya, though a superb variety in fruit, is unfortunately a very shy bearer, and Yama-tsuru (syn. Yamato) yields a small fruit and is apt to greatly overbear. Zengi is so small as to be of little value, except for home use, but its flavor is superior.

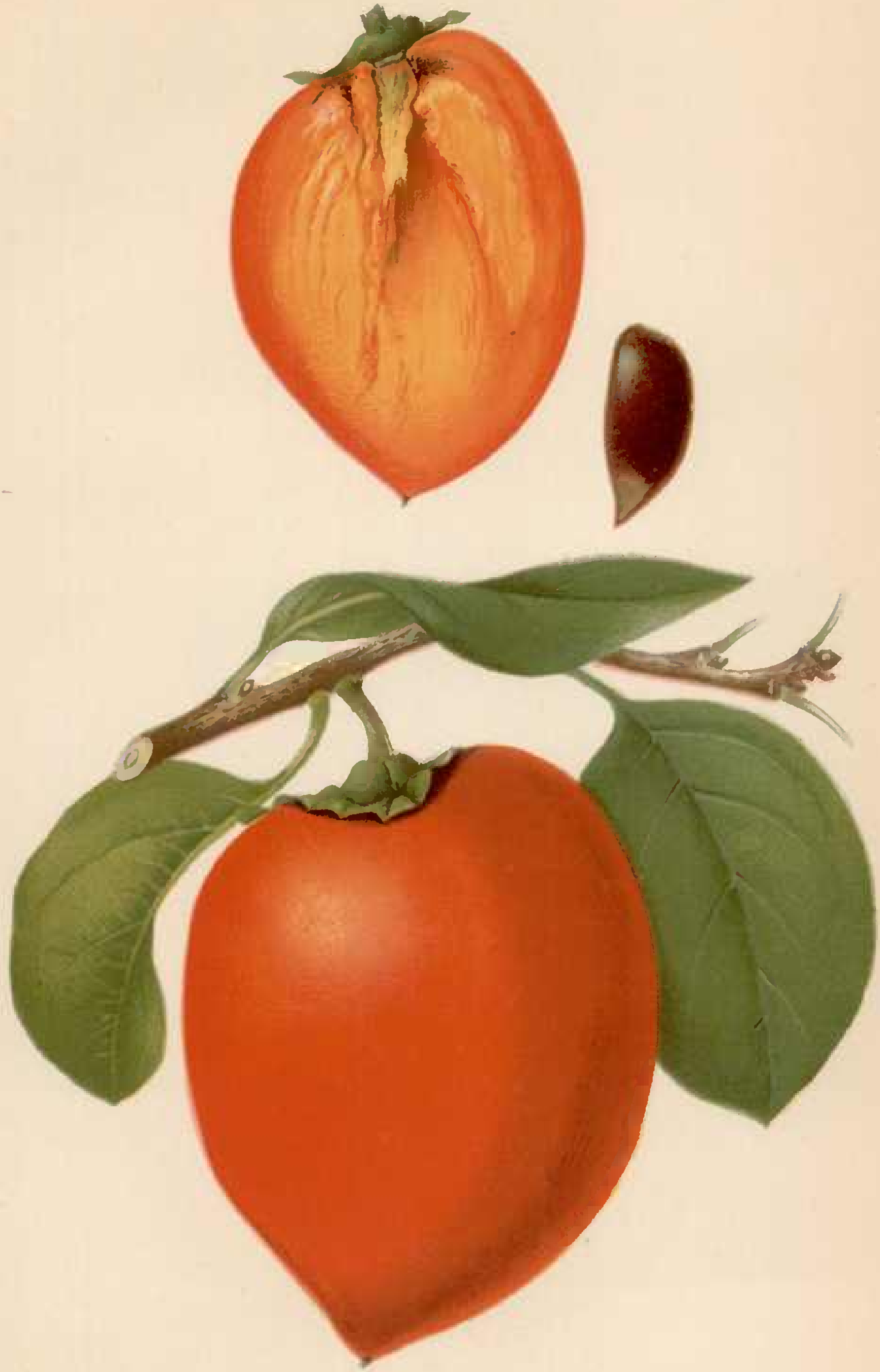
It may be proper to describe and illustrate here two varieties which, after several years of careful study of numerous specimens, have been quite fully identified and understood. Including those mentioned in my former reports, beginning with 1887, eleven named varieties of the kaki have been described and illustrated, but there are others as to the identity of which I am yet in doubt. So much care has been taken in arriving at conclusions that it is quite certain the varieties so far described are properly named. If further investigations should prove that no mistake has been made it would be a matter of congratulation, since even among persons having the most information on this difficult subject, both in this country and in Japan, there has been the greatest diversity of opinion with reference to the matter.

Dai-Dai.—Size of fruit, medium to large, averaging nearly 3 inches in diameter; shape, round with but little depression at the base, a slight cavity at the apex; sur-



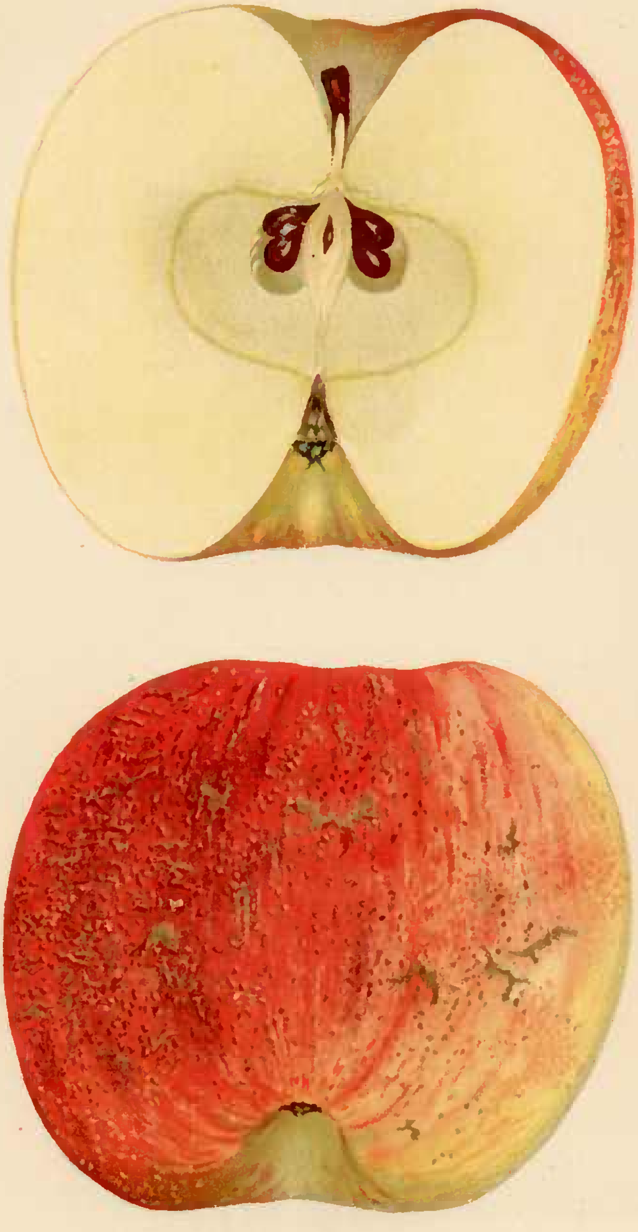
Wm H. Prestele, Fecit

DAI DAI.



Wm H Prestele Fecit

YAMA TSURU.



YORK IMPERIAL.

face, smooth and quite free from dark specks or cracks; rather pale orange in color; flesh, orange-red, soft when fully ripe; seeds, plump, usually present; flavor, rich, sweet; quality, very good. As to the meaning of the name there is difference of opinion among the Japanese, some saying that it means "Big-Big," and others that it has reference to the resemblance of the fruit in shape and color to an orange. The illustration on Plate IV was made from a specimen from Florida.

Yama-Tsuru.—Size, small to medium, from 1½ by 2 to 2 by 3 inches in diameter; shape, oblong, distinctly pointed and peculiarly inclined, one side being larger than the other; stem set on a slight elevation or cone, instead of a cavity, as with most kinds; surface smooth, little or no dark marks; color, bright red; flesh, deep orange, rarely any dark flecks; flavor, very sweet; quality, very good. The name means mountain or wild crane—*yama* meaning mountain, or, literally interpreted, wild, and *tsuru*, the stork or crane. A Japanese pomologist says it is perhaps the wild progenitor of the larger and more improved variety called Tsuru. The illustration on Plate V was made from specimens selected from a number received from Florida.

SEEDS, PLANTS, AND SCIONS DISTRIBUTED.

This branch of the work of this division is prosecuted with as much energy as the very limited appropriation will permit. There being no money at command with which to purchase seeds, plants, or scions of fruits, about all that can be done is to secure donations, and I am happy to state that many generous persons do all that they can in this direction.

KAKI.

Fifteen varieties were received from the minister of agriculture of Japan. These had been collected with great care, and, in accordance with our request, from different parts of the empire. Some of them have not been previously imported to this country and are said to be among the hardiest varieties known in Japan. Others were standard varieties which are already growing here. There were two trees of each of the following kinds:

Saijio (Si′-zhō), which is the name of a town in the province of Aki. It is said that the fruit is large, oblong, pointed, bright red, and commonly used for drying.

Tsuno-Magari (Tsū′-nō-Mä′-gä′-ry), *tsuno* meaning horn, and *magari* curved; the name therefore signifies curved or crooked horn.

Zenji (Zĕn′-gy). Zenji is the name of a county in the State of Shimuzuki. This variety was described in my annual report for 1890.

Wase-Hira (Wä′-sy-Hee′-rä). *Wase* means early, and *hira* flat. This variety is said to resemble Zenji in form. Its size is rather small.

Kuro-Kuma (Koo′-ro-Koo′-mä). *Kuro* means black, and *kuma* bear. This is a variety belonging to the cold region of Japan. The fruit is said to be large and of very excellent quality.

Shimo-Maru (Shee′-mō-Mä′-roo). *Shimo* means frost, and *maru* round, the name being descriptive of the variety, which is able to endure frost, and bears fruit round in shape.

Daijyo-in (Dī′-zhō-ĭn). Daijyo is the name of a temple in the State of Kaga. This is astringent until fully ripe, which is not until after frost.

Hassaku (Hăs′-săck-oo). This word has reference to the time of year corresponding to August 1, the time for women to celebrate worship to the "god of work."

Tsuru-no-ko (Tsoo′-roo-nō-kō), meaning the young of the crane. This variety is described in my report for 1890.

Hachiya (Hä-chee′-yä). This name is that of a county in the State of Mino. The variety is described in my report for 1887.

Yemon (Ā-mōn). This word is the name of a badge that is worn on the outside of clothing. The variety is described in my report for 1887.

Uza-yemon (Oo′-zä-ā-mōn). Uza being the name of the man who originated a variety closely resembling Yemon, or perhaps from its seed. It is said to be astringent until frosted.

Hiyakume (Hyä′-koo-māy). This is one of the most common varieties in Japan, and will be found described in my report for 1889. There is a difference of opinion among Japanese as to the meaning of this name, some saying that it has reference to the fruit weighing 100 "me," which is a unit of Japanese weight; and others that

it means 100 eyes, referring to the abundant and peculiar eye-like marks near the apex of the fruit.

Yedo-Ichi (Yĕd'-ō-Itch-y). This is another popular variety that has also been described in my report for 1889. The translation of the name is Yedo's Best.

Tane-Nashi (Tä'-ny-Năsh'-y), *Tane* meaning seeds, and *Nashi* without; the name therefore signifies seedless, which is usually the case with the fruit. This is one of the best varieties in cultivation and is described in my report for 1887.

These trees were made into two sets, comprising one tree of each kind, one set being sent to the director of the Florida Experiment Station, at Lake City, and the other to R. D. Hoyt, of Seven Oaks, Fla., to be propagated in both cases, so that the young trees may be distributed. It is hoped that some of these varieties will prove hardy enough to endure the winters of the more northern States, but it was thought best to have the original trees all set south of the line of danger from winter-killing, and to test the young trees afterwards in the North.

CITRON.

In response to a special request, there were received from the United States consul at Bastia, on the island of Corsica, ten rooted cuttings, which were said to be of the choicest variety of the citron cultivated there. No name was given in the accompanying communication, and, for the sake of convenience, I labeled them "Corsican" when sent out. Three plants each were sent to T. T. Eyre, of Myers, Fla., and Mr. Frank A. Kimball, of National City, Cal., and two each to Mr. R. D. Hoyt, Seven Oaks, Fla., and the State experiment station at Pomona, Cal.

DATE.

From the United States consul at Muscat, Arabia, there were received six plants of the Fard date, which had been especially ordered. These were rooted suckers and came through in excellent condition, having been planted in tubs of earth. One each was sent as follows: To the State experiment station, at Phœnix, Ariz.; H. W. Blaisdell, at Yuma, Ariz.; agent Southern Pacific Company, at Indio, Cal.; Frank A. Kimball, National City, Cal.; and to the State experiment stations at Pomona and Tulare, Cal.

MISCELLANEOUS.

Scions of thirty-nine varieties of the apple were collected from correspondents in different parts of the country. Nearly all of these varieties were entirely new. The scions were distributed to localities in which it was thought they would best succeed. Eleven varieties of the pear were collected and distributed, all of them being new and some of them as yet unnamed. Also, four varieties of the plum (*Prunus Americana*) namely, Charles Downing, Hawkeye, Ocheeta, and Piper; twelve varieties of the strawberry, nearly all of which have been received and sent out under restrictions from the originators not to allow them to be placed upon the market, but only to be tested; five varieties of the gooseberry, all of which are as yet held for trial; two new seedling varieties of the dewberry, Skagit Chief and Washington Belle, both of which are as yet untested, except in the State of Washington, where they originated; and besides the above, seeds, cuttings, and plants of a few other fruits, including nuts, which it is unnecessary to enumerate.

FRUITS RECEIVED FOR EXAMINATION AND IDENTIFICATION.

From the organization of this division in 1886 there has been a steady increase in the appreciation by the public of its work in endeavoring to identify varieties of fruits for correspondents and to pass unbiased judgment upon new kinds. In my former reports mention has been made of this fact, but there has been such a marked increase of this work in the last year that at times to promptly examine the specimens and answer the accompanying communications has overtaxed our facilities. Over 3,000 separate varieties have been received at this office during the year. A careful record has been made of each, and one or more letters written to the sender. Many valuable new varieties, not known except perhaps on the farm where they originated, have been discovered and steps taken to have them tested in different parts of the country. In some cases old varieties, thought by correspondents to be new, have been identified and their reintroduction under new names, with resulting confusion, has been prevented. In other cases the naming and introduction of new seedlings have been discouraged because of their poor qualities. As the fruit lists are now already very large, it is deemed unwise to add new kinds unless decidedly better than others of the same season. I am happy to say that, with few exceptions, persons sending such have, after a little argument, acquiesced in the judgment of this office.

Very full descriptions and drawings have been made of about 500 varieties, and accurate models of about 300.

Among the most promising of the newer varieties are the following, of which only brief descriptions can be given in the limited space devoted to this report. It is hoped that this may lead to their more general trial.

APPLES.

York Imperial.—This notable winter apple, though not new in some sections, is deemed of so much value for both market and family use and adapted to so large a territory as to deserve special mention. The variety originated at York, Pa., and was brought to public notice in 1855, but only before small local associations. In 1871 it received from the American Pomological Society very high commendations for cultivation in Pennsylvania, Virginia, and Maryland. Since then it has been grown in nearly all the apple sections of the country with remarkable success. It is one of the most popular kinds grown for market in the States above mentioned, and is often called in Virginia by the synonym Johnson's Fine Winter. For several years I have noted its good behavior in the orchards of Kansas and Missouri. In Illinois and Indiana it does well, and also in California, where a few trees have been planted. There is not a market apple now known which is more worthy of being planted. The tree is vigorous and well shaped, forming a round head and being an abundant bearer, although not too productive. One objection to it is the peculiar oblique form of the fruit, which makes it difficult to pare on a machine. It may be described as follows: Fruit, in size medium to large; form, round or oblong, diameters nearly equal, angular, oblique; surface, smooth, sometimes having russet patches; color, yellow, with indistinct red stripes over a lighter shaded red; basin, deep, wide, abrupt, regular, or slightly plaited; eye, nearly closed; cavity, deep, narrow, russeted; stem, short; core, small, closed; seeds, numerous, small, plump; flesh, yellow, firm, juicy, a little coarse; flavor pleasant, subacid; quality, good to very good; season, December to spring in the central States. An illustration of a typical specimen will be found on Plate VI.

Avista (A. J. Phillips, West Salem, Wis.).—An oblate conical apple of medium size, fairly good appearance, and mild, subacid flavor; noted for its hardiness and constant bearing qualities, having borne twenty-three consecutive crops; season, winter.

Alden (same source).—An apple medium to large in size, conical, of good appearance; hardy and productive in the Northwest; quality, scarcely good; season, winter.

Bradford's Best (T. V. Munson, Denison, Tex.).—A medium sized, globular, dull-red apple; flesh yellow, fine grained, juicy; of very good quality and a long keeper.

Lehigh Greening (W. B. K. Johnson, Allentown, Pa.).—A large green apple of good quality, and apparently a better keeper than Rhode Island Greening.

Kochers (same source).—A large globular apple, yellow-striped and splashed with crimson; flesh, yellow, fine-grained; sprightly subacid; quality, very good; season, winter.

Dudley (Prof. W. M. Munson, Orono, Me.).—A seedling of Oldenberg, similar to it in size, color, and quality, but a winter apple.

Gordon's Cluster (J. W. Kerr, Denton, Md.).—Of medium size, globular in form, red, with stripes of darker red; very good quality for an early apple (received August 4), and a profuse bearer.

Palouse (George Ruedy, of Colfax, Wash.).—A beautiful winter apple, above medium size; oblong conical; finely striped and of very good quality; season, early winter.

Early Breakfast (Uriah Thomas, Iola, Kans.).—A large handsome summer apple of best quality. This variety should be well tested.

Cross (F. M. Benham, Hagerstown, Md.).—A large oblate apple; greenish-yellow, striped with light red; ripening at same season as Twenty Ounce, to which it is superior.

Fay's Gem (S. Gordon, Seargeantsville, N. J.).—A crab apple, best quality.

Rebel (C. R. Wood, Washington, Va.).—A medium-sized, oblate, high-colored apple of fine dessert quality.

Worszt, No. 451 Russian catalogue (J. H. Masters, Nebraska City, Nebr.).—This large handsome Russian variety is one of the best of its class that has been received at this office; fruit, oblong, truncated, with deep cavity and basin; color, greenish-white, well covered with rich carmine stripes; quality, good; season, August in Nebraska.

Shining Aromatic, No. 973 Russian catalogue (same source).—Another handsome apple of medium size, pentangular in shape; color, pale yellow, faintly shaded with light red; quality, only good; season, August in Nebraska.

Raspberry, No. 288 Russian catalogue (same source).—An oblong medium-sized apple of delicate light red color and medium quality; season, 1st of August in Nebraska.

Rambour Queen, No. 502 Russian catalogue (same source).—An oblong irregular fruit of large size, yellow, splashed and striped with crimson; flavor, pleasant; quality, good; season, August and September in Nebraska.

Oro (J. J. Blackwell, Titusville, N. J.).—Oblate, medium size; yellow-striped and splashed with bright carmine; flesh, yellow, fine-grained, juicy; flavor, mild, subacid, rich; quality, very good; season, early winter in New Jersey.

Malinda (John S. Harris, La Crescent, Minn.).—An oblong conic apple of medium size; greenish-yellow, bronzed on one side; flesh, white, fine-grained; quality, good; season, early winter in Minnesota; reported as a very hardy tree and a constant bearer after it attains age; should be top-worked on early-bearing varieties.

Lilly of Kent (A. N. Brown, Wyoming, Del.).—Large, globular, green with light shading of yellow and bronze; flesh, greenish-yellow, fine-grained, juicy; flavor, mild subacid; quality, very good; apparently an all-winter keeper.

Lankford (Charles Wright, Seaford, Del.).—A large oblong variety; pale green, shaded with pale and dark red; flesh, greenish-yellow, fine-grained, juicy, sprightly, subacid; quality, very good; a long keeper.

Dickey (A. D. Kline, South Salem, Ohio).—A flat apple of medium size; yellow, shaded and splashed with red stripes; flesh, yellow, fine-grained, melting; flavor, rich subacid; quality, nearly best; season, winter; a good and regular bearer.

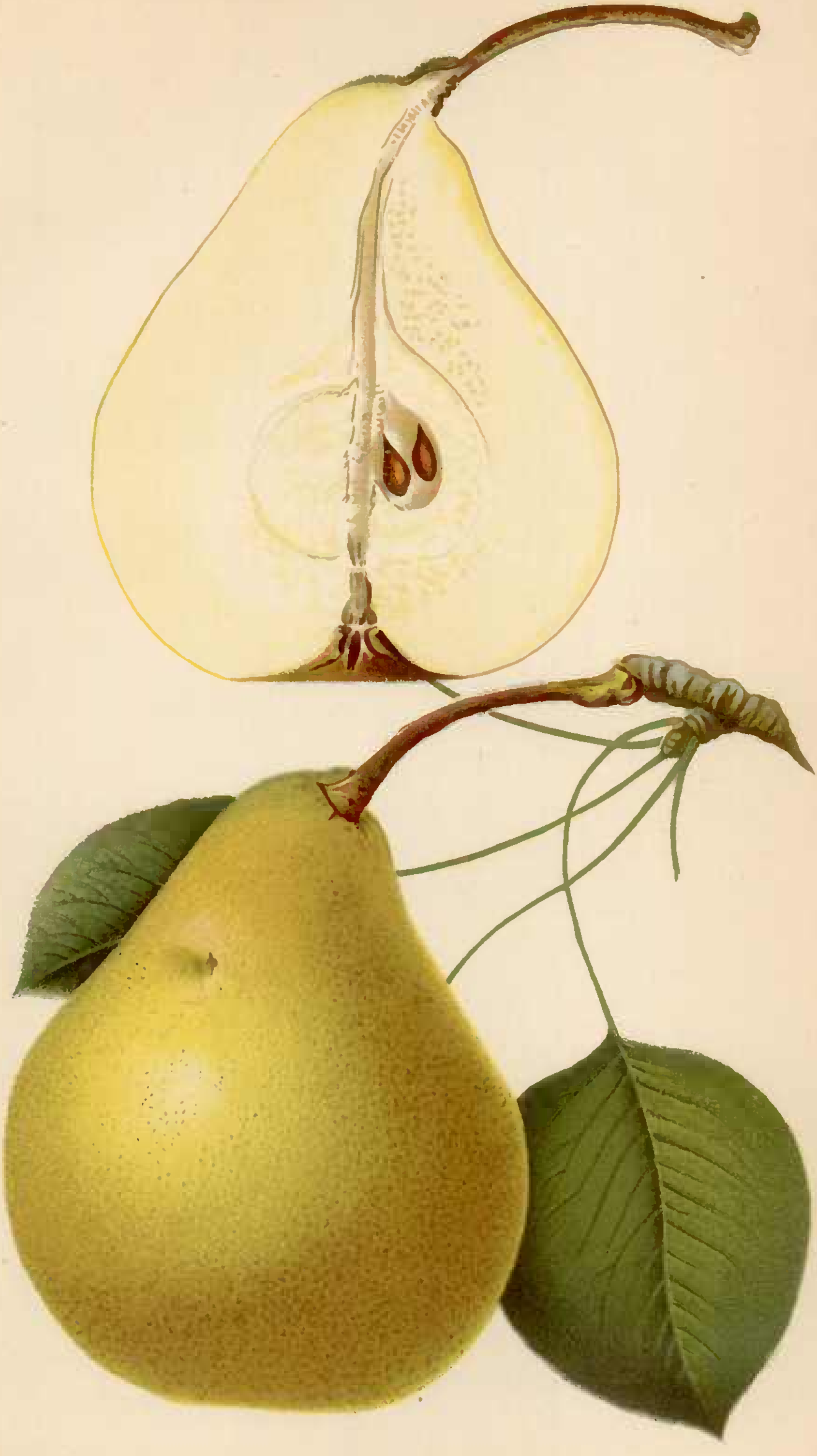
Blaine (E. P. Smith, Gresham, Oregon).—Oblong in shape, of medium size; golden yellow, almost entirely covered with stripes of light and dark carmine; flesh, white, with light stain, fine-grained, breaking; quality, good, fine for dessert; season, winter.

Seedling No. 1 (G. H. Horne, M. D., Latham, Ark.).—A large oblong cylindrical apple; very smooth and of a rich yellow transparent color; flesh, yellow, crisp, juicy; flavor, pleasant subacid, with a delightful aroma; quality, best; tree, a fine grower and an early bearer.

PEARS.

Vermont (J. T. Macomber, Adams, Vt.).—A small fruit, pyriform in shape; color, light yellow with very bright carmine blush; flesh, white with but little granulation; flavor, subacid, pleasant; quality, good; season, September.

Gans (Elbert W. Ryan, Mount Airy, Ohio).—Shape, pyriform, regular; size, $2\frac{1}{4}$ to 3 inches in diameter; color, yellow, with slight brownish cheek on the sunny side; surface, smooth; stem, $1\frac{1}{2}$ inches long, slender, set in a slight depression, and usually curved and inclined to one side; basin, shallow, broad, regular; calyx, open; flesh,



GANS.

CROSBY

BURBANK

Wm H Prestele, Fecit

free from grain, tender, melting, juicy; core, small; flavor, rich, sugary, very good. Does not rot at the core. Mr. Ryan gives the following history of the variety: In 1871 Mr. Joseph Gans (pronounced Ganz) found the tree growing in the woods near his farm, in the vicinity of Cheviot, Ohio. He removed it before bearing age to his own farm. When it bore, the fruit was found to be very desirable, and Mr. Jackson, a nurseryman, showed it before the Cincinnati Horticultural Society, where it was named Gans. The old tree is from 6 to 7 inches in diameter and 25 feet high, and of a handsome conical shape; the twigs are heavy and of upright habit, and the tree bears abundantly. The present owner this year sold 5 bushels at $2.20 per bushel, when the best Bartletts were only bringing $1.50. Its season, judging from the specimens received here, is from the first to the middle of August in southern Ohio. Plate VII shows an averege specimen.

QUINCES.

Flavoring (Luther Burbank, Santa Rosa, Cal.).—A large pyriform, turbinate fruit; golden yellow; flesh, white; good quality, very highly flavored.

Van Deman (same source).—Oval truncate; size, large; color, greenish-yellow; flesh, yellow; flavor, subacid, mild; quality, best. This variety is one of the very best in every respect that I have ever examined, and the tree is reported as exceedingly thrifty and productive. After several years' trial Mr. Burbank considers it the best of his hundreds of new seedlings, and has named it as above.

Santa Rosa (same source).—Another very choice new quince. It is very highly colored and has the peculiar quince flavor strongly developed, and yet can be eaten raw like an apple. Free from fuzziness.

Johnson (W. B. K. Johnson, Allentown, Pa.).—Large, handsome, similar to orange.

PEACHES.

Lucia (Wallace Foster, Indianapolis, Ind.).—A large globular fruit; yellow-shaded with rich purple red; flesh, a rich yellow, with red next the stone; flavor, mild subacid, almost sweet; quality, best; clingstone; season, last of September.

Albright (H. M. Engle & Son, Marietta, Pa.).—A large ovate fruit; greenish-white, splashed and washed with red; flesh, white, melting, moderately juicy; vinous sweet; quality, good; freestone; season, middle September.

Lancaster (same source).—Medium size, round; color, yellow washed with red; flesh, reddish yellow, melting, juicy, rich; of superior quality; freestone; season, middle August.

Michigan (C. Engle, Paw Paw, Mich.).—A large round fruit; yellow shaded with dark red; flesh, yellow; subacid with slight bitter deposit around the stone; quality, very good; freestone; season, first September.

Crosby (W. J. Hinds, Townsend, Mass.).—Size, medium, about 2 inches; shape, round or oblate, sometimes being compressed towards the apex; cavity, medium; suture, moderately deep and extending from the base to beyond the apex, often causing the tip to be sunken; color, bright yellow with crimson splashes and stripes, very attractive; skin, moderately thick with short pubescence; flesh, bright yellow, red at the stone, juicy; stone small, blunt, parting readily from the flesh; flavor, mild subacid, rich; quality, above medium; season, the last week in September in Massachusetts, ripening just before Crawford Late. The tree is described as low, spreading, and willowy, resembling Smock, Hill's Chili, and Wager, and is not a strong grower. The leaf is of medium size, thick, grayish-green, with prominent reniform glands. The blossom is small, and of a dark pink color. This peach was sent out about 1876 by Mr. Crosby, a nurseryman of Billerica, Mass. It was afterwards propagated and distributed in a small way by the Massachusetts Agricultural College, and has been locally known as Excelsior. The fact that there is another variety already on the list named Prince's Excelsior made a change of name necessary, and, the matter having been referred to this division, the name Crosby was finally selected, in honor of the originator. This peach comes with the statement that in northern Massachusetts and New Hampshire it has fruited for ten consecutive years, though standard varieties have in that time borne only two or three crops. Prof. S. T. Maynard, of the Massachusetts Agricultural College, thinks the fruit much like Wager, but as it has fruited several years when the latter variety entirely failed, it would seem that the varieties are certainly not identical. In fact, the principal point in its favor above other varieties is the unusual hardiness of the fruit buds. The tree bears abundantly and the fruit is quite even in size, although not large. Mr. J. H. Hale says: "I believe for the North it has a Concord-Bartlett-Baldwin combination that must make it a very valuable commercial variety." The colored illustration, Plate VIII, was made from specimens of average size; they were grown by Mr. W. J. Hinds, of Townsend, Middlesex County, Mass.

Dumont (W. G. Voorheis, South Frankfort, Mich.).—A medium-sized fruit; dark

yellow, nearly red; flesh, of red orange color, melting, vinous, pleasant; quality, very good; freestone; season, last of September.

Roberta (W. J. Cowing, Washington, D. C.).—Medium size, round; color, reddish yellow washed with dark red; flesh, reddish yellow; flavor, rich, sugary, vinous; quality, superior; freestone; season, first to middle of August.

Hughes I.X.L. (L. T. Sanders, Plain Dealing, La.).—A medium-sized fruit; color, greenish-yellow, mottled and striped with deep crimson; flesh, lemon yellow; flavor, mild subacid; quality, medium; clingstone; season, last of October in Louisiana; may be profitable in the South.

Olden (J. C. Evans, Olden, Mo.).—A large roundish fruit; color, creamy yellow shaded with red; flesh, white, very melting, juicy; quality, very good; freestone; season, first half of September in southern Missouri.

"*Gold Dust*" (same source).—A medium-sized roundish fruit; yellow washed and splashed with light to very dark red; flesh, very rich yellow, juicy; flavor, sprightly, rich; quality, very good; cling; season, last of August.

Phillips (J. T. Bogue, Marysville, Cal.).—A large round fruit; color, a rich lemon yellow shaded lightly with red; flesh, yellow, firm, meaty, juicy; flavor, mild subacid; quality, nearly best; cling; season, first half September.

McDevit (same source).—A large round fruit; color, a fine lemon-yellow, striped, shaded, and clouded with red; flesh, yellow, firm, juicy, rich; flavor, almost sweet; quality, best; cling; season, first half September.

Washington (J. W. Kerr, Denton, Md.).—A medium round fruit; color, greenish yellow shaded with beautiful red; flesh, lemon yellow, very melting, juicy; sprightly, subacid; quality, best; freestone; season, first half September.

Kerr's Cling No. 1 (same source).—A large ovate, pointed fruit; color, light yellow washed and shaded with red; flesh, yellow, firm; flavor, vinous; quality, good; cling; season, first half of September in Ohio.

Champion (I. G. Hubbard, Nokomis, Ill.).—A large globular fruit; color, creamy white, washed and striped with red; flesh, white, slightly pink at stone, melting, juicy, firm; vinous; quality, good; season, last half of August.

PLUMS.

Burbank (Luther Burbank, Santa Rosa, Cal., and S. D. Willard, Geneva, N. Y.).—Fruit, of medium size; form, roundish, conical, tapering towards the end opposite the stem; cavity, regular, deep, abrupt, with peculiar leather-crack marks; suture, scarcely perceptible; stem, stout, half-inch long; apex, a mere point; surface, smooth, with very little bloom; cracks and dots of brown sometimes apparent; color, dark red or purplish, running into bright amber, with the yellow undercolor showing through in patches; dots, numerous, minute, brown; skin, of medium thickness, tender, peeling easily from fully ripened specimens; flesh, amber yellow, melting, juicy; stone, small to medium, pointed, clinging to flesh; flavor, rich, sugary, resembling other Japanese plums; quality, best. This variety was imported from Japan by Mr. Burbank, December 20, 1885, among a lot of seedlings; but, as it proved upon coming to fruiting age to be superior to many of the named kinds, he sent specimens to this office in 1887, and it was named in this division in honor of the introducer. The fruit carries remarkably well and the tree appears to be entirely hardy, at least as far north as Geneva, N. Y., where it has fruited this year. It is also a very good producer. I think it deserves extensive trial, as persons who have already tested it are contemplating planting it largely for market. The specimens shown in Plate IX were received from Mr. S. D. Willard, of New York.

Longworth (J. W. Van Deman, Geneva, Mich.).—A medium-sized oval fruit; color, reddish purple; flesh, amber yellow, breaking; sweet, pleasant; quality, good; resembles Lombard, except that it is a freestone; season, first half September in northern Michigan.

Columbia (S. H. Feathers, Damascus, Oregon).—This fine plum, while not a new one, has not been as widely disseminated as it deserves; fruit, large, roundish; color, brownish purple; flesh, yellow orange, transparent, melting, juicy; flavor, sweet, rich; quality, best; season, first half September.

Rockford (C. G. Patton, Charles City, Iowa).—A small roundish fruit of the *P. Americana* type; color, dark carmine red; flesh, dark yellow, very melting; flavor, sweet, aromatic; quality, best; season, September; nearly a freestone.

Champion and *Van Deman* (H. A. Terry, Crescent City, Iowa).—Seedlings of Hawkeye of good size; very productive, of good quality, and fine for market.

Wild No. 3 (Agnes M. Johnson, Laurel, S. Dak.).—A small round fruit of dull-red color; flesh, yellow, rich, pulpy; excellent; skin, quite tender; season, September.

A wild plum of *P. Americana* type (Royal Church, Harrisonville, Ohio).—This plum was grown by J. B. Holt, of Rutland, Ohio, and is the largest specimen of native plum received at this office. Round, truncate in form; color, yellow shaded and

spotted with coppery red; flesh, yellow, melting, juicy; mild subacid; quality, very good; clingstone; season, first half September.

A branch thickly set with choice fruit, showing beneficent result of arsenical spraying, was received from William Smith, of Carmi, Ill.

GRAPES.

Delawba (L. C. Chisholm, Spring Hill, Tenn.).—A seedling of Delaware and Catawba; cluster, compact, cylindrical, slightly shouldered; color, brownish amber with delicate lilac bloom; pulp, moderately firm; flavor, sweet.

Superb (A. F. Rice, Griswoldville, Ga.).—Bunch, large to very large; cluster, shouldered and much divided at base, terminating in a very slender tip; many berries abortive; berry, round, medium, black with blue bloom; skin, medium thick, very tough; pulp, firm, so that berry is hard even when ripe; pulp readily dissolves; rich, juicy, sweet; no bitterness or acridity; quality, excellent.

Magnificent (same source).—Bunch, medium to large, rather short; broad shouldered, not compact; berry, medium to large, dark red with purplish bloom; skin, thin, tender; pulp, tender, melting, no bitterness; juice, plentiful, rich, sweet; quality, excellent; a promising table grape.

Dr. Warder (Theophile Huber, Illinois City, Ill.).—An early black grape of best quality, a week or more earlier than Concord.

Marie Louise (same source).—A white grape of most exquisite flavor and well worthy of trial.

From T. V. Munson, Denison, Tex.—Twenty-two varieties of new hybrids, many of which are of great interest. Some are crosses with new species of our American wild grapes which have not yet been brought into cultivation. The importance of the origination of such varieties as these can scarcely be overestimated.

From T. T. Lyon, South Haven, Mich.—Specimens of fifty varieties, many of them being new.

STRAWBERRIES.

Lida (*imp.*) (Prof. L. R. Taft, Agricultural College, Mich.).—A medium-sized berry, conical, dark crimson and glossy, with seeds regularly arranged in broad depressions; flesh, dark, rather tender, sweet and melting, not aromatic; productive, with fruit on strong trusses.

Alabama (Julius Schnadelbach, Grand Bay, Ala.).—Medium size, long, conical, smooth, and regular, with seeds very slightly depressed; crimson, with dark seeds; firm enough for market; subacid.

Stevens (same source).—Medium size, round conical, blunt, calyx large; crimson, with yellow seeds; subacid; very firm; an early variety.

Dr. Morain (Jules Fonta, New Orleans, La.).—Imported from France; berry, large, long pointed, slightly ribbed; rather light in color and soft in texture, but of excellent flavor; promising for home use and near market.

Salter (Edmund Gookin, Ponchatoula, La.).—Medium-sized, conic, dull crimson, with depressed seeds; rather sour, and lacks firmness, but is grown for shipment to Northern markets.

Strickland, (*imp.*) (same source).—Large, oblong conic, scarlet, with large dark seeds; rather sour; foliage, very dark and glossy, free from rust; later than Salter; grown for shipment North.

Estelle (A. H. Smith, Paw Paw, Mich.).—Round, conical, light crimson, with dark seeds; quality, good, but rather soft.

Michigan (same source).—Much like Bubach in form, but darker in color and firmer in flesh; large, rather rough, with depressed calyx; flavor, subacid, pleasant. Both *Estelle* and *Michigan* are seedlings originated with C. Engle, Paw Paw, Mich.

Fairmount (Oakley Apgar, Califon, N. J.).—Long conical, regular, rather seedy; flesh, firm, dark, juicy, subacid, pleasant; very good color and texture for market; firm enough for long shipment.

Lovett (Prof. T. L. Brunk, College Park, Md.).—Medium size, round, irregular, sometimes truncated, compressed and grooved; calyx large, often doubled, bright green, and depressed; color, light crimson; seeds, large; firm, but juicy, sprightly subacid; promising as an early market berry.

Enhance (Henry Young, Ada, Ohio).—A large, sharp conical berry, the first berries to ripen being inclined to be rough; bright crimson with slight gloss; flesh, dark, firm, and of good flavor when fully ripe; promises well for market.

Farnsworth (Charles A. Green, Rochester, N. Y.).—A medium-sized, round conical berry of excellent quality, but too light in color and not firm enough for market; promising for home use.

Lehigh (*imp.*) (W. B. K. Johnson, Allentown, Pa.).—A berry that very closely resembles Crescent, but is claimed to bloom a week later and to ripen its fruit several days later than that variety. It is worth testing by growers of the Crescent.

RASPBERRIES.

Kansas (A. H. Griesa, Lawrence, Kans.).—Originated on the farm of Mr. Griesa, in 1884, as a chance seedling. Although he had growing at that time several hundred other young seedlings from carefully selected seeds, this proved better than any of them. It is an early black cap, somewhat resembling Gregg, but the fruit is larger and of better color, being almost free from bloom. Although juicy and excellent in flavor, it is firm enough to ship well, as specimens received at this office from Kansas, along with other varieties, abundantly proves. The illustration on Plate X was made from specimens received from the originator this year, and does not represent the variety above its average in size, some berries being much larger. The plant seems to have not only unusual vigor, but to withstand the trying climate of Kansas and other States where raspberry culture is carried on with difficulty. It has been thoroughly tested in many parts of the country, along with other new varieties as well as old ones, and is, almost without exception, very favorably mentioned. A noticeable feature is the extreme readiness with which the plant makes tips. They often root so early in the season as to send up little canes before the growth stops in the fall, and of course the plantlets are well rooted, and when transplanted start off with vigor the next spring.

Seedling No. 4 (same source).—Round; drupes closely set; black, with heavy bloom; clusters, large; quality, good; late.

Hiram (W. J. Bradt, North Hannibal, N. Y.).—A very large, sharp conical berry; color, pale crimson, with a light bloom; not so firm as Cuthbert, but a fair shipper, and of good quality.

Extra Late (same source).—A large, heavy fruit; flattish round; of fair quality; having no bloom; a better-looking berry than Gregg, which ripens a little later.

Royal Church (Royal Church, Harrisonville, Ohio).—Fruit, large, round, crimson; drupes, large; core, rather large, holding berry better than Shaffer; flavor, rich and good.

Perfection (G. J. Kellogg & Sons, Janesville, Wis.).—Originated by F. W. Loudon; said to be a cross between Cuthbert and Turner; berry, large, roundish, elongated; drupes, large, showing suture; dark crimson, with bloom; rather soft and juicy, though tart; a handsome berry, and apparently very productive, though not so firm as Cuthbert.

Japanese Raspberry (Rubus phœnicolasius), syn. Japanese wineberry (H. R Miles,. Harper's Ferry, W. Va.).—Berry, round, drupes small; deep red, glossy; seeds, small, smooth, easily crushed; a handsome berry, of medium size, and fairly firm; flavor, subacid, somewhat sprightly, pleasant. More ornamental than useful.

BLACKBERRY.

Eldorado (E. M. Buechly, Greenville, Ohio).—A medium to large blackberry of excellent quality; fruit, oblong, conical, irregular, with very large drupes, and small seeds and core.

A thornless blackberry (John I. Sterling, Benton Harbor, Mich.).—Early, and of fair size and quality. The long fruit stems and general habit suggest an infusion of *R. Canadensis* in this variety. The old canes are thornless. There are a few scattering thorns on the under side of the leaves. Worth testing by market growers.

GOOSEBERRIES.

Oregon Champion (Dr. A. W. Thornton, West Ferndale, Wash.).—A large, oval, bright green berry, showing the tomentum of the English varieties; quality, fair, not equal to Downing. Specimens of this variety were also received from John Boerstler, Vashon, Wash., with bearing wood, which is stocky, and of a light gray color, with long thorns.

Bennet's Eureka (same source).—A large, obovate or pear-shaped berry, of a dull green color; flavor, rather a sharp acid.

Cedar Hill (same source).—A large oval berry, with long adherent flower parts and a few scattering prickles; skin, thin; pulp, quite rich. Dr. Thornton writes of this (which originated with him): "An upright grower, of good size, very prolific, as much so as Champion or Houghton; perfectly mildew proof" [in Washington].

A lot of seedling gooseberries (Phil Strubler, Naperville, Ili.).—These were numbered consecutively 1 to 10, inclusive; Nos. 1 to 5 are early to medium, and Nos. 6 to 10, late. They are said by Mr. Strubler to be seedlings of Downing, Smith, and Mountain. Nos. 1, 2, and 4, seem to be pure American, and are promising early varieties. Nos. 6, 7, and 10 resemble Mountain, but are larger, earlier, and of better flavor.

KANSAS.

Wm H. Prestele, Fecit

Wm H Prestele Fecit

GUAVA.

1. Mexican (Psidium lucidum)
2 West Indian (Psidium Guava)
3 Cattley (Psidium Cattleyanum)

Puyallup Mammoth, *Triumph*, and *Randolph* (same source), grown on bushes received from the introducers in Washington, Pennsylvania, and Missouri, are apparently identical and of English parentage.

Portage (A. H. House, Mantua Station, Ohio).—A large, round or slightly oblong berry; yellowish-green with light yellow veins, thin pubescence, and scattering prickles; skin, rather tough and thick; pulp, rather acid; a good cooking berry.

Pearl (J. F. Taylor, Douglas, Mich.).—Originated by Prof. William Saunders, Ontario, Canada; round, medium size, very light green, transparent, with a bloom and no pubescence; very productive, and of excellent quality.

CURRANTS.

Improved Long Bunch Holland (George P. Peffer, Pewaukee, Wis.).—Leaf closely resembles Long B. Holland, but racemes are much longer and berries larger; berries, very uniform in size.

London Market (Henry Bowles, Belknap, Mich.).—"An English variety imported in 1878;" racemes of moderate length, thickly set with large, light crimson berries; somewhat resembles Fay, but is more delicate in texture; firm, transparent, rather sharp acid, and seeds large and numerous.

Baldwin's Black (same source).—An English importation; apparently an improvement on Black Naples, in size, productiveness, and length of cluster; otherwise identical.

BUFFALO-BERRY.

Specimens of buffalo-berry (*Shepherdia argentea*) were received from Agnes M. Johnson, Laurel, S. Dak. It is a very promising wild fruit, perfectly hardy in the cold climate of the North and Northwest.

PERSIMMON.

Alton.—A promising new persimmon (*Diosprypros Virginiana*) was received from E. A. Riehl, Alton, Ill., of good size, rich yellow in color, very sweet, and of excellent quality; fruit reported as selling in Chicago market at $6 per bushel. This fruit ripened without frost.

DATES.

Fruit from a tree grown from seeds distributed by the Department of Agriculture about 1877, from George N. Hitchcock, San Diego, Cal.

Specimens of three seedlings, from F. T. Eisen, Fresno, Cal.

A cluster of seedling dates of good quality, from W. C. Maloney, Key West, Fla.

NUTS.

Milford (O. C. Cook, Milford, Mass.).—A hickory nut of medium size, easily cracked, and separating from the shell nearly entire. Kernel of best quality. A variety of the little shellbark, *Hicoria alba*. Should be thoroughly tested by grafting.

Shinar (Samuel C. Moon, Morrisville, Pa.).—Another little shellbark hickory nut of superior quality. The kernel is very tender and rich in flavor, and is easily extracted from the shell; worthy of propagation.

Leaming (R. J. Leaming, of Sedalia, Mo.).—A little shellbark hickory that has a shell opening, when cracked, in such a way as to expose both halves of the kernel, allowing them to be extracted whole; of the best quality.

Jewett (W. R. Stuart, Ocean Springs, Miss.).—A large thin-shelled pecan, somewhat angular, and compressed near the center of most specimens; the kernel separates easily from the shell and leaves no astringent particles attached.

San Saba (E. Risien, San Saba, Tex.).—A medium-sized pecan, of excellent quality, thin shell; very little spongy growth on kernel; flavor excellent.

Post (Herbert Post, Fort Worth, Tex.).—A large pecan, of rather thin shell; opens fairly well, and of good quality.

Faust (O. D. Faust, Bamberg, S. C.).—A pecan of large size; very long in shape; quite thin shell; kernel separating readily from shell; quality, best.

THE GUAVA.

Among the tropical fruits this is one of the most common and popular even among the most careless and ignorant. Some call it the "peach of Florida." There are about fifty botanical species, and all, perhaps

with one exception, are native of the tropical regions of the American continent, and are not found in any other part of the world except where introduced by man. None are found wild within the United States except as chance seedlings which have escaped from cultivation. Seeds are abundant in all species and germinate very freely. They are about the size and shape of those of the tomato, and the internal structure of the fruit resembles that vegetable. The flavor is quite peculiar and pronounced, and at first not always liked. To the taste the fruit is a pleasant acid. The crop usually ripens in the late summer, although some varieties bear fruit during the entire year. All kinds are said to grow from cuttings. The three following-named species have been quite well established in Florida, and to some extent in California:

Psidium guava ("common guava," "apple guava," "pear guava;" Plate XI, Fig. 2).—This species is a native of the West Indies, and is so very tender that even the slightest frost seriously injures or kills back the trees. If killed to the ground the stocks send up numerous sprouts which soon bear fruit. It propagates naturally by sprouting from the roots for many feet in all directions from the parent tree, and this habit is sometimes quite annoying. The size and form of the tree are somewhat like the peach, and it bears abundantly. The leaves are from 4 to 6 inches in length by 2 inches in width, and not glossy. There are numerous varieties of this species, the fruits of which differ slightly in form, size, and color. Usually, however, they are from 2 to 3 inches in diameter, of an oval shape, and pale lemon-yellow in color. The names "pear" guava and "apple" guava come from their resemblance in form to these fruits. The surface is smooth but not glossy. The flesh is either pink or whitish yellow in color. The peculiar odor is so strong that a few specimens will perfume a large room, but the taste is a pleasant subacid. The guava jelly, which is known the world over as one of the most delicious of all conserves, is made chiefly from this species. However, jelly of excellent quality can be made from any species of this genus. The fruit is also eaten fresh with sugar and cream, or preserved and canned as are other fruits.

P. Cattleyanum ("strawberry guava").—This is a native of Brazil, and a much more hardy species than the former, as it will endure a slight frost without serious injury. It takes the form of a bush from 3 to 6 feet high, and is a most profuse bearer. The leaves are very much smaller than those of the former-named species, and of a different shape, as is shown by the illustration (Plate XI, Fig. 3). They are also quite different in texture, being thick and glossy. The fruit is small, rarely exceeding 1¼ inches in diameter, and pyriform, with the apex at the blossom end. In color it is a rather dull red, with numerous brown dots on the slightly roughened and not glossy surface. The flavor is pleasant though decidedly acid, somewhat resembling the strawberry, and free from the strong odor of *P. guava*. There is little variation in the fruit of its seedlings.

P. lucidum ("Mexican guava," Plate XI, Fig. 1).—This species, in Florida improperly called "yellow cattley guava," has been less cultivated than the others, but is of no less importance. It is more a shrub than a tree, and is quite as hardy as *P. Cattleyanum*. The leaves are small, thick, and shiny. The fruit is borne in abundance, and is from 1 to 2 inches in diameter, according to variety. The shape is nearly round, and the color is pale lemon-yellow. The surface is smooth and free from dots. In flavor it is quite tart, and has but little of the peculiar guava smell.

MEETING OF THE AMERICAN POMOLOGICAL SOCIETY.

The twenty-third biennial session of the American Pomological Society was held in Washington in September, in response to the following invitation:

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
WASHINGTON, D. C., *January 16, 1891.*

Mr. P. J. Berckmans, President American Pomological Society:

DEAR SIR: Allow me, through you, to invite the American Pomological Society to hold its next biennial meeting, which I am informed is to take place in September, at the Agricultural Department, in the city of Washington.

The Department will, I assure you, be happy to arrange for the meeting, and provide a suitable hall and such other conveniences as you may require, should you honor us with your presence.

Yours very truly,
J. M. RUSK,
Secretary.

This invitation was promptly accepted by the executive committee of the society, and the meeting was held September 22–25, in the lecture hall of the National Museum.

This society has numbered among its members the foremost pomologists of the country, and many important advances in the improvement of our fruits have been placed on record at its biennial meetings. Its reports on the nomenclature and value of varieties are everywhere regarded by fruit-growers as the highest authority on those subjects. Through its published reports and fruit catalogues it has done more to condense and make available to the general public the existing information on methods of culture and adaptation of varieties to particular localities, etc., than any other single agency. The fruit catalogue of this society is as yet the only reliable compilation of varieties that applies to the various fruit-growing regions, and its wider circulation among farmers and fruit-growers would do much toward preventing the annual waste of thousands of dollars' worth of fruit trees and plants put out every year by planters who have not sufficient knowledge of the varieties adapted to their localities.

The attendance at the meeting was good. Most of the States east of the Mississippi and many west of it, including California, were represented. The program of essays and addresses included papers on a wide range of topics, arranged under three general heads, viz, scientific pomology, commercial pomology, and miscellaneous papers on pomological topics. While limited space will not permit more than a mere mention of many of the papers, brief references to some of them may not be out of place in this report.

At the opening session, after the call to order by President Berckmans, the address of welcome was delivered by Hon. Edwin Willits, Assistant Secretary of Agriculture. He referred briefly to the remarkable advances made in the improvement of our fruits since the organization of the society, in 1848. At that time California and Florida were unknown as fruit-producing regions. The orange, the lemon, the fig, the Japanese persimmon, the pomegranate, the pine-apple, the olive, were essentially luxuries, imported from foreign shores. The tomato, though tempting to the eye was, in many localities distasteful to the palate, if not positively injurious. The strawberry was yet, in a large measure, only a product of the meadows.

"But it is useless," he added, "to enlarge in illustration of the condition at the date of your organization. A complete revolution has

been wrought. In this revolution you, gentlemen, and those whom you succeed and whom you represent have been an important factor. The improved methods you have brought about; the new varieties you have propagated and introduced; the new fruits you have brought from foreign lands and made popular; the assiduity with which you have studied soil, and climate, and adaptability; the genius you have shown in discovering and devising new strains of flavor and of increased production; the sacrifices you have made and the fortunes you have spent in the endeavor to secure a hardy stock with the most acceptable qualities, all have been recorded, and will be gratefully remembered by generations who enjoy the luscious pleasures you have brought to their repasts. Many of your names have been household words for years. You have given joys that never satiate and sweets that never pall. Where before an improved fruit was so rare that it was a benefaction, now there is such an abundance that one can hardly discriminate and can hardly distribute his appreciation." The speaker then referred at some length to the work of the Department of Agriculture in lines affecting pomology, and invited the hearty coöperation of the society, that still better work might be accomplished.

In response to a request from the president, Hon. C. L. Watrous, of Des Moines, Iowa, thanked the Secretary of Agriculture for the kind invitation and cordial reception tendered the society. He referred to the successful work of the Department and to the feeling of assurance on the part of the society that the work would be continued. He expressed it as his opinion, based on observation of the different plans adopted by various governments, for promoting the interests of agriculture, that in no other country has a government department devoted itself so successfully to securing the welfare of the common people. Referring to the work of members of the society from beyond the Mississippi, he spoke of recent attempts to perfect and develop the hardy wild fruits of the West and the prospect of success in that line of pomological work.

In the address of the president, Mr. P. J. Berckmans, attention was called to the fact that the official recognition of the society by the Secretary of Agriculture gave it "as truly a national standard in name as it has always had in deeds."

One of the objects of the society is to educate the people concerning fruits. Though not so stated in the constitutional clause defining their duties, much of this work devolves upon the vice-presidents for the various States. The biennial meetings of the society are not sufficient to accomplish its work. The progress of pomology will largely depend upon the personal efforts of the vice-presidents and members in the several States. By personal intercourse and correspondence, the fruit-growers of the various counties and localities should be aroused to the importance of organizing and supporting State, county, and local societies. These can hold more frequent meetings, and by discussion and comparison the merits and demerits of fruits may be ascertained. Annual reports to the State society, of which these local societies should be auxiliaries, would enable the chairmen of the State fruit committees to make more reliable reports than can be obtained where State and local societies do not exist.

Though the society was founded to advance the interests of the science of pomology and can not recognize individual interests, the wonderful advance in the production of fruits makes it necessary that commercial fruit-growing shall receive due attention. Commercial fruit-growing as it now exists is in a measure the result of the scientific work of this society.

Discussing the causes of recent decline in the prices of fruit, President Berckmans said that in many cases they are local, and therefore general remedial measures can not be suggested. He mentioned the following as among these causes:

(1) Overproduction in some localites.
(2) Irregularity in transportation, which prevents daily shipments and causes an accumulation of the ripe fruit for several days.
(3) The shipment of larger quantities to a market than it can consume.
(4) Inferior quality or faulty packing, which prevents ready sale and decreases the price of similar fruit of a better grade.

The remedies suggested were the adoption of rules by local societies concerning the grades of fruit to be shipped; the appointment of inspectors, if necessary, to inspect the fruit before shipment; and the packing and shipment under the official brand of the society, indicating the name and grade of the fruit in each package.

Fungous diseases and injurious insects are increasing in some sections with alarming rapidity. In combating these the fruit-grower must call in the aid of the scientist. He should, however, acquire all possible knowledge of entomology and kindred sciences to enable him to intelligently observe the appearance and effects of these enemies, that he may aid in the work of investigation, the results of which, thanks to the Government, are placed within the reach of all.

Concerning the fruit catalogue and its revision Pres. Berckmans said:

The aim of the official catalogue of the society is to present a list of fruits that have proved of value in the largest area of the States in which they are now rated. This catalogue was begun twenty years ago and has received most careful revision at each biennial session, but it is to-day not giving as much information as is necessary. This is because of the difficulty of so dividing our immense territory as to show the geographical and climatic regions wherein many of our popular fruits become modified to a greater or lesser extent and their value greatly changed. Several plans were suggested when the work was at its inception; and that of dividing into subdistricts such States as included regions of great difference in climate, elevation, etc., was carefully considered. This latter plan would have been adopted but for the voluminous tabulation necessary to show the rating of the fruits for the various sections. The present form was considered to be the best one then practicable. While insufficient in some instances, it has been retained until a better plan is suggested. This is a matter which I suggest for your consideration.

The labors of the committee on synonyms have been made more arduous by the introduction of well-known sorts under new names and by the addition of other names to those of new varieties held under a registered trade-mark, in order to disseminate them without liability of legal proceedings. The originator of a new and valuable fruit should receive a just remuneration for the years of care and labor required for its production. But by applying for a "trade-mark" or "registered label" he does not always retain a monopoly of the variety. This arises from the utter impossibility of indelibly impressing such a mark upon anything but an inert manufactured article. The "registered-label" plan induces fraud and adds to the confusion of our nomenclature. There are doubtless other methods to secure remuneration to the originator of a new fruit which would be more effectual.

The various Japanese fruits imported by California firms are adding a most confusing and perplexing nomenclature. Local names, usually without significance, or misspelled because of the difficulty of writing in English characters sounds which to any but Japanese ears are mere murmurs, have increased this perplexity. Many new Japanese fruits have proved of great value in several sections of the United States, but the difficulty in arriving at a correct nomenclature has caused inferior sorts to be cultivated and entailed failure, when better sorts offered under similar names would have yielded abundant returns. This subject, I trust, will meet your careful consideration during the session.

SCIENTIFIC POMOLOGY.

In a Paper on "The Possibilities of Originating a Class of Pear Trees Exempt from Blight," Prof. T. J. Burrill, of Illinois, stated that in his opinion such a class of trees can be developed. He mentioned Tyson,

Seckel, and Angouleme as varieties comparatively free from blight, and advocated the growing of seedlings from them in order to secure blight-proof pear trees which will furnish fruit of good quality.

Mr. E. F. Smith presented tables showing results of a three years' test of various fertilizers that have been recommended as preventives of peach yellows. His conclusion is that a practical test on a large scale, covering a period of three years, and in one of the best possible localities for such a test, has shown that chemical fertilizers (including the mixture recommended by Goessman and Penhallow) are practically worthless as a remedy for peach yellows, and has also shown that they have no efficacy even as a preventive.

Prof. B. T. Galloway briefly outlined the methods pursued in investigating plant diseases and the results accomplished during the past few years. He described the approved forms of apparatus for applying the fungicides used to prevent pear leaf-blight and apple scab, and emphasized the importance of the subject to the fruit-grower. He estimated the damage to the apple crop in 1890, by scab alone, to be $6,000,000, and said that the total damage to the fruit crop of the country by such diseases as blight, mildew, leaf-blight, rot, and yellows is not less than $50,000,000 annually. In the investigations "a great many difficulties have been encountered, and while some have been overcome, others remain to be mastered."

Dr. C. V. Riley presented an instructive paper on "Recent Advances in Dealing with Insects Affecting Fruits." In this he discussed the methods of combating the plum curculio, codling-moth, red scale, fluted scale, and other injurious insects, giving the result of recent experiments on those insects. Contrary to the expressed opinions of many horticulturists, Dr. Riley questions whether more injury is done to-day to our fruits than was done fifty or one hundred years ago. In fact, it is patent that with the advances made of late years in our methods of warfare against these fruit pests less injury relatively is done, but as the area of fruit culture increases, so does the aggregate of injury and also the number of species that we have to contend with. He warned pomologists to be on their guard against two foreign insects likely soon to appear in this country—the peach ceratitis, a subtropical insect resembling the apple-maggot, which is extremely destructive to the peach crop of Bermuda and likely to be troublesome if it once becomes established in Florida and Georgia, and the Japanese peach fruit worm, which is allied to our codling-moth, and in some seasons damages 90 per cent of the peach crop of Japan. He suggested that provision be made for the inspection, at ports of entry, of fruits and plants received from any part of the world from which we know danger threatens.

A practical and suggestive paper was that of Hon. C. W. Garfield, of Michigan, on "Some Local Pomological Problems." The writer urged the necessity of paying more attention to local conditions in recommending varieties for planting. What succeeds in one locality may fail in another. Even on different fields of the same farm this is the case. Speaking of a case that came under his own observation, he said:

The Grand River and 6 miles of territory separate me from a colony of fruit-growers, my warm friends. We meet in council; and they insist that the Gregg is a hardy raspberry, of good quality; that the Shaffer is a poor thing, unworthy of cultivation; that the Ohio has nothing to commend it, while my immediate neighbors unite with me in combating them on every point, and widely proclaim that the Gregg is tender, the Shaffer a great success, and the Ohio a model market black cap. The dissimilar judgments are based upon conditions that are widely at variance. The Hill's Chile peach has been condemned by a whole section of our State as too poor a peach to grow, and is highly commended by another locality. Both are right. Each locality

has its peculiar conditions, affecting this variety differently. The man who asks how to make his orchard bear is given counsel by another whose conditions are as dissimilar as it is possible to make them. And still the successful man *knows* he is right and gives his advice without reservation. I would not minimize the value of our national gatherings in the interest of pomology, but the man who goes a long way from home to get advice as to what varieties to plant or how to manage them is liable to be misled. His local conditions are those to be studied, and hence the need of carefully conducted experiments in our own neighborhoods.

Other interesting papers under this head were:

Cross Fertilization, Chancellor C. E. Bessey, University of Nebraska, Lincoln, Nebr.; Immediate Effects of Cross Fertilization as Affecting Quality and Commercial Value of Citrus Fruits, Rev. Lyman Phelps, Sanford Fla.; Fruit Districts, Geologically and Climatically Considered, Prof. E. S. Goff, Experiment Station, Madison, Wis.; Heredity and Environment in Originating New Fruits, Prof. Thomas Meehan, Germantown, Pa.; Horticulture at the Experiment Stations, Prof. J. S. Newman, Auburn, Ala.; Pear Blight and Climate Influences, G. F. B. Leighton, Norfolk, Va.; Physiological Effects of Pruning, Prof. L. R. Taft, Agricultural College, Mich.; Section *vs.* Whole Roots in Propagating the Apple, Prof. J. L. Budd.

COMMERCIAL POMOLOGY.

Mr. J. H. Hale, in an address on "How to Make Small Fruit Culture Pay," laid much stress on thorough preparation of the soil, asserting that while different soils need different treatment, thorough preparation whether in drainage, fertilizing, or tillage, or in all of these, will be found profitable. In his experience in Connecticut he had found potash and phosphoric acid to be the plant foods most needed. Wood ashes or cotton-hull ashes give the best form of potash. He uses 200 bushels of wood ashes with a ton and a half of fine ground bone per acre. As a rule, but little nitrogen is needed, as it increases the tendency to grow foliage. Some varieties will be benefited by an application of nitrogen, however—as, for example, the Marlboro raspberry—on soil where Golden Queen and Cuthbert do not need it. The Marlboro is a feeble grower and needs strengthening. Hill culture is preferred to matted rows for all small fruits. To secure large, bright, and firm fruit, raspberry hills should not be closer than 6 feet, and for strong growers like Cuthbert, 7 or even 8 feet is better. Irrigation is profitable in strawberry growing, where it is at all possible. In many cases it prevents crop failures that would otherwise occur. Marketing demands much thought and study. It pays the grower to study the methods of packing to be seen in the fruit that comes to his market. Fruit of a uniform grade, nicely put up, and marked with the grower's name and address, is sure of a market. The eye of the buyer must be caught and his attention held by the superior quality and packing of the fruit. The grower's name should have a positive value in the market as the result of his persistent adherence to the policy of sending out only good fruit. The home is, after all, the best market for the American fruit-grower. Farmers, and even orchardists, have too little of small fruit on their tables. Half a bushel of fruit per day the year round can be profitably disposed of by the average family. A Connecticut farmer kept an account of the small fruit grown on half an acre of ground and used by his family last year. He charged the family with the fruit at market rates and found it amounted to $365, or more than $700 per acre. Such small-fruit culture pays, not only in the money value of the product, but in the healthful outdoor habits of life which it encourages, and the hundred other ways in which a garden ministers to mental and physical health.

Mr. J. T. Lovett discussed "New and Promising Small Fruits." Among strawberries Cloud (imp.) was recommended to the Southern grower for shipment North. Michel was considered valuable on account of

extreme earliness, and Lovett's Early worthy of mention. Other strawberries were characterized as follows: Lady Rusk (imp.), plant of moderate growth, evidently requiring deep, rich soil; Jucunda Improved, a strong and vigorous grower even upon sandy loam, fruit in all respects resembling closely its illustrious parent; Crawford, excellent for exhibition purposes, but demanding high culture and heavy soil; Yale, resembling Crawford, fruit firmer but not so large; Louise, fine for the amateur, but requiring high culture; Edgar Queen (imp.), resembling Sharpless, but more productive and ripening fruit better; Eureka (imp.), of the Sharpless type, more productive but not so large; Mrs. Cleveland (imp.), very vigorous and productive, but fruit of light color, quite soft, and medium size; Waldron (imp.), has few equals in size and productiveness, but lacks firmness; Viola, apparently identical with Monarch of the West; Iowa Beauty, without exception the most beautiful strawberry he had yet grown, but how well it will succeed generally is not yet determined; Parker Earle, the most promising variety for general culture that has recently appeared, productive, large, of good quality, in firmness to be classed with Sharpless; Gandy, the latest to ripen, is large, firm, and excellent, but requires high culture. The first three varieties are early, the last one late; the others ripen at mid season.

Of the black raspberries, Kansas and Lovett were mentioned as being early; Progress and Older as promising for second ripening, and Palmer, Cromwell, and Carman as closely resembling Souhegan. The only new red raspberry mentioned, Thompson's Early Prolific, was highly praised. Child's Japanese Wineberry, cane of strong growth and ornamental fruit, ripens at close of raspberry season, is attractive in appearance, but too soft for transportation, and too sour for most people.

Of blackberries, Early King seemed to Mr. Lovett to possess much merit as an early sort, especially for the home garden. Others were mentioned as follows: Thompson's (Early Mammoth), evidently a seedling of Wilson's Early, and very like it in many ways; Minnewaski, the best substitute for Kittatinny, ripening ten days after Wilson; Lovett's Best, taking all things into consideration, the most promising of the new varieties; Child's Everbearing Tree Blackberry, or Topsy, apparently a hybrid between *Rubus cuneifolius* and *Rubus villosus*, retaining the stout upright cane and villainous spines of the former and the large fruit of the latter, productive, late, large, soft, of good though not high quality, and not hardy.

Of currants, Mr. Lovett had found Fay (prolific) a success. He thought North Star to promise well, but not yet sufficiently tested; Black Champion, an improvement upon the old Black Naples, having berries larger and more productive; Crandall, to have some merit for culinary purposes, and to make a good jelly.

The gooseberry industry has not been successful with Mr. Lovett, the plant having lost its leaves prematurely and failed to ripen its fruit.

Dwarf Juneberries were reported to have given considerable satisfaction at the East, the chief complaints being lack of productiveness and susceptibility to fungous attacks. The variety "Success" is best, but is better for canning, etc., than as a dessert fruit. *Eleagnus longipes* was mentioned as an interesting fruit. It is very productive; its fruit is about three-fourths of an inch long by one-half an inch in diameter, tender and juicy, with one long, shapely, pointed seed in each berry, but too acid for dessert. It is a substitute for the cranberry.

Other papers under this head were: "Apple Growing Commercially Considered," Hon. F. Wellhouse, Fairmount, Kans.; "Commercial Peach-

growing," J. F. Taylor, Douglas, Mich.; "Berry Culture, Profits, and Failures in Georgia," Dr. Samuel Hape, Atlanta, Ga.

MISCELLANEOUS.

Concerning "Results of Recent Experiments With Small Fruits," Mr. T. T. Lyon stated that the great mass of recent originations among strawberries have been accidental seedlings.

So pronounced is the popular preference for size and color that quality seems to have been almost if not wholly overlooked, till, as a rule, its importance may be said to hold but an inverse proportion to size in the varieties of to-day as compared with the primitive type. That the pistillate varieties are so notably abundant to-day, and so obviously increasing in number, may be reasonably attributed to the objectionable though very convenient and common practice of employing pistillates in the process of reproduction from seed—a result in accordance with the universal law of nature, that like may be expected to produce like.

Of the raspberries, of the *Idæus* and *strigosus* types, Cuthbert, Golden Queen, Herstine, and Reder are among the best. Blackcaps vary but little as yet, perhaps because of their very recent introduction to cultivation. Certain varieties, such as Purple Cane, Shaffer, and a few others, possess so many characteristics in common with the blackcaps as to indicate a possible hybridization, and, if so, pointing to at least the possibility of even greater improvement in the same direction.

Among blackberries, but few, if any, of the improved varieties compare favorably with the wild product in regard to quality. Size and productiveness have been increased. White, light-colored, and spineless varieties have from time to time been brought to public notice, but so far few, if any such, have proved valuable, indicating at least a possibility that these variations may be due to lack of constitutional health or vigor. No variety has so far shown absolute hardiness in the open ground, and it may fairly be deemed improbable that such condition can ever be realized.

None of the recent introductions among currants surpass, if indeed they equal, in real value the oldest varieties upon our lists. The chief alleged improvement, and that a very slight one, is increased size of fruit. A supposed hybrid between the cherry currant and the wild yellow-flowering currant of the West has recently been introduced, with no apparent evidence of such hybridization, either in the account of its origin or the characteristics of either its plant or fruit. The fruit, when cooked, is sprightly and rich in flavor, and would be eminently desirable for such purpose but for the exceeding thickness and toughness of the skin. Neither the plant nor its fruit is, so far, attacked by either insects or fungi; hence the variety may be found useful, if only as the basis for further improvement. Among gooseberries, Houghton is scarcely exceeded, except in size, by Downing and Smith, which, though reported to be natives, possess certain characteristics indicative of at least partial foreign origin. Industry and several other foreign varieties, reported to be less subject to mildew than most other foreigners, are apparently only tolerable in this respect under specially favorable conditions. The increased popular demand for this fruit has apparently drawn into public notice several novelties, some of foreign origin and others of at least partial native parentage, nearly all of which have yet to establish a reputation.

Several alleged varieties of the wild Service Berry which grows in our Northern States have been recently introduced, but they can scarcely yet be said to have passed the experimental stage. Plantings have, so far, been generally of limited extent. The fruit, which ripens somewhat in succession, proves so specially attractive to the birds that its value, when planted more extensively, can scarcely be determined.

None of the species of *Vaccinium* seem to have been successfully subjected to either garden or field culture, though occasional alleged successes are reported. Apparently the most promising species for such purpose is the swamp blue-berry (*V. corymbosum*). Success has been reported (we think from New Hampshire) with one of the others (probably *V. Canadense*) in field culture, by burning over the ground to destroy other growths, and thus securing a crop of this fruit after a subsequent growth of one year.

Hon. D. W. Adams, of Tangerine, Fla., in a paper on "Pruning for Citrus and Other Fruits for Florida," took the ground that the first and inevitable result of cutting any tree is to do it a direct and irreparable injury; that pruning either root or top destroys existing balance and makes necessary a readjustment of the functions of the roots and foliage, causing a suspension of growth, and as a final result a smaller tree than if it had gone unpruned. Pruning for growth he characterized as absurd. He added:

Some prune to make trees bear well. There is no doubt it does make them bear, for it is an accepted fact that anything which threatens the vitality of a plant causes it to make an effort to reproduce its kind. The only reason, then, why pruning does make a tree bear is because it threatens its vitality. We complain loudly of the rapid increase of those hostile insects and dangerous diseases which now attack our trees and plants. In my opinion, the prevalence of both is due almost wholly to the low vitality and disarranged circulation caused by our defiance of the laws of nature. In attempting to improve upon nature we have got so far removed from her that, continually thwarted, she is unable in her own chosen and proper way to control these diseases and insects. So the duty devolves upon us—with what success, satisfaction, and profit, each can answer for himself.

Mr. Mortimer Whitehead, special agent in charge of Division of Agriculture "B," of the Eleventh Census, in a paper on "Pomology in the Eleventh Census," presented some startling preliminary figures concerning the magnitude of the fruit-growing interest of the country.

The viticultural interest was found to cover 401,261 acres of vines, of which 307,575 acres were in bearing, producing 572,139 tons of grapes. It would require about 60,000 railroad cars to move the commercial crop of grapes in 1889. The industry represented an investment of $155,661,150, and furnished employment to 200,780 persons. The vines are now growing that will within three years produce a crop of 8,000,000 to 10,000,000 boxes of raisins. This is more than the present entire consumption of the country, which is about 7,500,000 boxes annually.

The peach acreage in the United States was found to be 507,736; value of produce, $76,160,400; hands employed, 226,000. Upward of $90,000,000 was found invested in peach-growing in the census year.

Concerning the nursery interest, it was found that a capital of $52,425,669.51 is invested; 172,206 acres of land are used, and the grand total of young trees in nurseries in 1889 was 3,386,855,778. Of these, 518,016,612 are fruit trees, 685,603,396 grape vines and small fruits, and the balance nut, deciduous, and evergreen trees, hardy shrubs, and roses.

The writer stated that in the final compilation of the completed census the investment in horticultural pursuits will be shown to be more than $1,000,000,000.

For various reasons the writer urged that in the future collection of statistics everything pertaining to agriculture, including its census, should be under the control of the Secretary of Agriculture.

Other papers, either read or ordered printed in the report of the society, included—

Does the Spraying of Orchards with Insecticides Pay? Prof. C. M. Weed, College of Agriculture, Hanover, N. H.

General Fruit Growing, G. C. Brackett, Lawrence, Kans.

Fruit Notes from a Canadian Standpoint, L. Woolverton, Grimsby, Ont.

Novelties in Pomology, H. E. Van Deman, U. S. Department of Agriculture.

Pomological Resources of North Carolina, Prof. W. F. Massey, College of Agriculture, Raleigh, N. C.

Small Fruit Growing in Eastern and Middle North Carolina, J. Van Lindley, Pomona, N. C.

The Grapes of Middle Virginia, Hon. Henry L. Lyman, Charlottesville, Va.

Fruits of Western North Carolina, H. S. Williams, Rockledge, Fla.

The Revised Nomenclature of Japanese Fruits, L. A. Berckmans, Augusta, Ga.

These papers, together with the discussions on them and the fruit catalogue of the society, will be found in the report of the society for the session of 1891.

The fruit exhibit, while not so large as at some former sessions of the society, was a creditable one. Specimens of a number of the newer varieties, as well as typical specimens of standard sorts, were donated by the exhibitors to the Division of Pomology. Wax models have been made of many of these for the working collection of the division.

REPORT OF THE MICROSCOPIST.

SIR: I have the honor to submit herewith my twentieth annual report as chief of the Division of Microscopy.

The work done during the past year relates in a great measure to the microscopical investigation of food adulterations, food fats and oils, textile fibers, and edible and poisonous mushrooms.

In relation to fiber investigations, I have had constructed, with your permission, a new machine of my invention for determining the general value and tensile strength of farmers' binder twine and for other purposes connected with farming interests. In these tests I have been courteously assisted by the officer in charge of the Bureau of Equipment of the Boston Navy-yard, and also by Mr. E. B. Balch, superintendent of the National Cordage Company, New York City. This machine is now in good working order. A number of experiments have been made with it, and the results of the preliminary trials are herewith furnished. It may be well to state here that this machine has no relation to another machine invented by me and illustrated herein, designed solely for testing and comparing the relative strengths of fibers and of threads. There is also furnished in this report an interesting statement of preliminary tests made with this machine of four samples of foreign flax, showing their relative strength as compared with their relative cost per ton. These samples of flax were received from Mr. J. M. Anderson, Belfast, Ireland.

During the past year I have also devoted considerable time to investigating and reporting upon wool fibers, and have testified officially in the United States courts, for the Secretary of the Treasury, in cases where such examinations were pertinent to a question of dutiable merchandise. Valuable samples of foreign and native wools have been added to the collection in this division through the courtesy of Mr. E. A. Greene, Philadelphia, Pa.; also of Mr. John Consalus, Troy, N. Y., and others.

It may also be proper for me to mention that I have in progress the preparation of a large collection of models representing, by casts taken from nature, the edible and poisonous mushrooms of the United States, in groupings and otherwise, illustrating their manner of growth, development, coloring, and as far as possible their diversity of habitat. In this line of work enough has already been done to shape roughly an exhibit for the World's Columbian Exposition, which exhibit, it is desirable, should be as comprehensive and perfect as the one in the museum at Nice, France, which shows the mushrooms prepared in plaster, life-size, and colored after nature. In this way the public is enabled readily to compare one kind of mushroom with another, and to study them in all their stages of growth.

With the approval and coöperation of the Assistant Secretary, I have, as already said, commenced my preparations for such an exhibit, which will be made as complete as the means placed at my disposal will permit.

Respectfully submitted.

THOMAS TAYLOR,
Chief.

Hon. J. M. RUSK,
Secretary.

IMPROVED METHODS OF DISTINGUISHING BETWEEN PURE AND FICTITIOUS LARD.

In consideration of the many requests received during the past year for such information as would enable one skilled in the use of the microscope to distinguish pure lard from fictitious lard, I have prepared a preliminary statement of experiments for those who desire to make microscopic observations in this line of research:

(1) Heat, over the flame of a Bunsen burner, in a porcelain capsule, 4 ounces of pure home-rendered leaf lard, for a period of one minute, and allow it to cool slowly until it solidifies, which will require a period of about four hours, in an atmosphere of about 75° F. The crystalline groupings of this sample will appear very small when viewed under a power of 100 diameters.

(2) Prepare, in like manner, another sample of pure leaf lard, heating it for a period of four minutes, and allowing it to cool slowly, as above. It will be observed that pure lard in this case shows well-defined crystals of stearin, viewed under the microscope as above, and will, without regard to the high temperatures to which it has been exposed, consolidate in about the same time as that given in the first experiment.

(3) Prepare a sample of compound lard consisting of commercial stearin and sufficient cotton-seed oil to bring the stearin to the consistency of good pure lard; heat four minutes, and allow this mixture to cool slowly as above. It will consolidate in about an hour at 75° F.

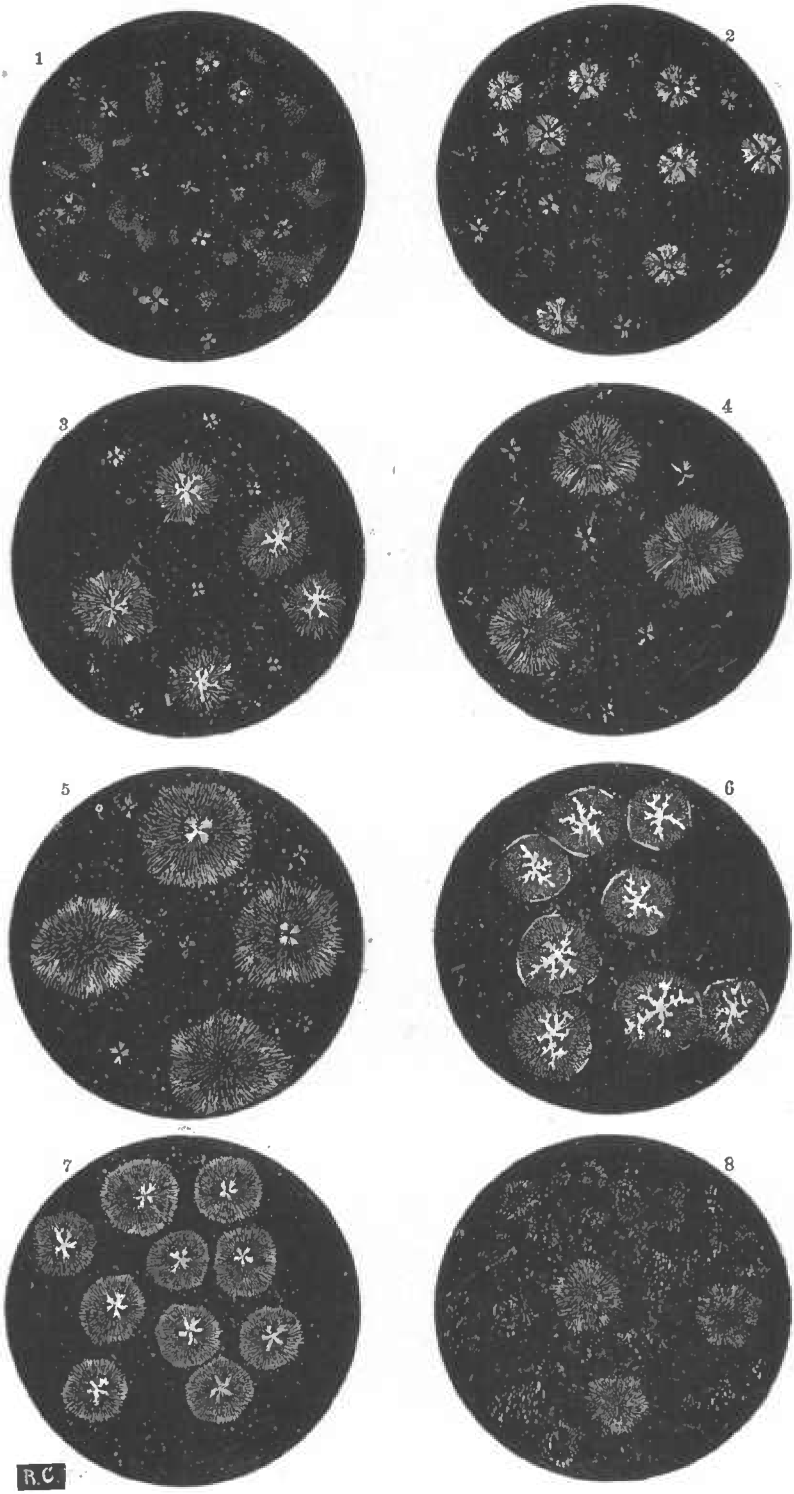
(4) Prepare a second sample of compound lard, consisting principally of commercial stearin to which a trace of pure lard has been added; heat this compound for a period of four minutes. This compound will also consolidate quickly, owing to the presence of stearin in large quantity.

(5) Prepare a third sample of compound lard, consisting of commercial stearin, oleo, and cotton-seed oil, with a trace of pure lard; heat four minutes, and allow it to cool slowly, at 75° F. In this case it will be observed that the time required for consolidation will depend upon the amount of stearin present.

(6) Prepare a sample of commercial oleo after the method of the first experiment. This, like pure lard, will require about four hours, at 75° F., to consolidate.

(7) Prepare a sample of commercial stearin, heating it four minutes. This will consolidate in about half an hour or less, at the temperature given above.

Some samples of compound lard are very deceptive in appearance, being smooth and translucent, especially such as are composed of lard and oleo, but these are easily detected by the use of the microscope and polarized light. My usual practice is, first, to examine each sample with the unaided eye, compressing a portion of the lard about the size of a large pin-head between two pieces of clear glass about one inch square each, and holding each sample up to the light to compare it with a sample of home-rendered lard similarly prepared. As fictitious lard contains a large amount of stearin, it will exhibit by this method of examination many white spots, which represent the crystallized stearin, and which are not seen in pure lard. The amount of natural stearin in pure lard is so small that it is not visible to the unaided eye by this method of examination; therefore the microscope should be used in the examination of pure lard, as the groupings of the crystallized fats of



PURE LARD AND FICTITIOUS LARD.

1, 2, and 8, pure lard; 3, 5, and 7, stearin, oleo, and cotton-seed oil; 4, lard and oleo; 6, stearin.

lard are very small. These groupings are in stellar forms, composed of spicules which proceed from a common center, frequently requiring to be magnified 400 times to discern, while the groupings of branched crystals of stearin are easily observed to advantage under a power of 100 diameters.

Stearin constitutes one of the principal fats of fictitious lard. It gives firmness to the other fats and is less soluble than palmitin. It is the first to crystallize when held in solution with other fats. Its branched groupings are easily resolvable under the microscope, and always appear very bright by polarized light. Taking advantage of these facts I heat, say, 4 ounces of a suspected lard in any suitable vessel, over the flame of a Bunsen burner. If the sample hardens quickly in a temperature of about 75° F., it will be found to contain a large amount of stearin. A sample, on the other hand, consisting principally of either pure lard or oleo, or of a mixture of these two, will consolidate very slowly as compared with a sample to which a large proportion of commercial stearin has been added. The first fumes which arise in the heating process will indicate somewhat the composition of the fat. If it contains a large amount of leaf or other lard, the lard odor will be easily recognized. If the sample contains only a trace of lard, the lard odor will be evanescent. If very acrid fumes arise during the heating process, producing a tendency to cough on the part of the observer, the presence of cotton-seed oil is indicated.

The two commercial solid fats which enter largely into compound lard, as at present manufactured, are commercial stearin and oleo, to which is generally added cotton-seed oil for the purpose of reducing the stearin to the consistency of pure home-rendered lard.

EXPLANATION OF PLATE I.

Plate I represents the various crystalline forms of pure leaf lard, lard compounds, and of compound fats sold as lard.

Figs. 1, 2, and 8. Crystalline forms of pure leaf lard.
Fig. 3. A compound of stearin, oleo, and cotton-seed oil.
Fig. 4. A compound of lard and oleo.
Fig. 5. Stearin, oleo, and cotton-seed oil.
Fig. 6. Stearin, cotton-seed oil, and a trace of palmitin.
Fig. 7. Stearin, oleo, and cotton-seed oil.

Samples 3, 5, 6, and 7 are varied in their proportions of stearin, oleo, and cotton-seed oil. When stearin is in excess in one of these compounds it appears in very bright, branching crystals in the center of each mass of crystallized palmitin. All fictitious lards abound in stearin. On being highly heated, and cooled slowly in a temperature of about 75°, the stearin, by reason of being less soluble than the palmitin fat, crystallizes first; following this, the palmitin crystallizes over the branching stearin crystals.

Viewed under polarized light with dark ground, the composition of the respective fats, stearin and palmitin, are at once distinguished one from the other. The cotton-seed oil, although a fat, is not observed under the microscope, as it does not crystallize at ordinary temperatures.

Pure lard, unless highly heated, exhibits a dull crystalline appearance as compared with stearin, because it consists mostly of palmitin and oil, with but a trace of stearin.

ADULTERATED COFFEE.

Several samples of imitation coffee have been sent to this division by citizens of this city for examination and report. This coffee imitates the color and form of the natural beans, and at first sight would readily deceive. My examination of the samples clearly shows the character of the substance used in its manufacture. Scraping off a small quantity of the bean and dissolving it on a glass slide, in a drop of water, I

examined the substance under the microscope with polarized light. I found that it consisted of dextrine made from potato starch. The starch granules were very much swollen, owing to the high temperature to which the starch had been subjected to convert it into dextrine.

Dextrine is a substance used largely instead of flour as a paste, and may be purchased wholesale at 4 cents per pound. It may be made from flour or from any starch. The granules of potato starch are easily distinguished from all others by their large size and peculiar form. They are polarizing bodies, and therefore show the prismatic colors when viewed with Nicol prisms.

To detect the spurious bean it is only necessary to throw a handful of them into hot water. If made of dextrine they will dissolve, while the natural coffee bean will retain its form.

FOUR EDIBLE MUSHROOMS OF THE UNITED STATES.

In my former publications relating to poisonous and edible mushrooms I have endeavored to make my description of species agree as nearly as possible with the common names in use in all English-speaking countries, giving at the same time their scientific names. It is acknowledged by all mycologists who have devoted much time to the study of mushrooms, edible or poisonous, that in order to obtain a knowledge of them it is necessary to study closely their respective structural forms and the color of their spores, gills, etc. Botanically considered, a glossary of terms is required for the beginner, and without one it would be difficult for the student to make much progress. Such a glossary has been added to this paper, and also a plate of sectional drawings showing at once the diverse forms of the cap, gills, and of the stalk. The requests of many correspondents leave no room to doubt that both glossary and plate will be appreciated.

It has also been deemed advisable to furnish for this report full-sized drawings, colored after nature and given in detail, so as to enable those possessed of botanical skill to distinguish the more readily one species from another.

In the Annual Report of this Department for the year 1885 was published my first paper, "Twelve edible mushrooms of the United States." This paper appeared to attract but little attention until several years after its publication, when a number of letters were received from various States and Territories of the United States asking for separate copies of the report. Ultimately, when the supply of this report had been exhausted, a new edition of the paper was issued, illustrated, and retaining the original title, "Twelve edible mushrooms of the United States." This was followed by a second illustrated paper entitled "Eight edible and twelve poisonous mushrooms of the United States," which first appeared in the annual report of the Division of Microscopy for 1890. The demand for copies of one or both of these two papers has greatly increased, requests having come in from all parts of the United States and from Canada, and from all classes of our people, affording evidence of a widespread interest in this subject, either from an economic standpoint or technically as a matter of plant study. Applications for these reports have been received also from various agricultural experiment stations. There is also a continued demand for more information on the cultivation of the well-known species *Agaricus campestris* and *A. arvensis*, the common meadow mushroom.

The successful cultivation of mushrooms on a large scale is carried

on extensively in many places throughout Europe and in Great Britain. Mr. John F. Barter, of London, England, who is considered the largest mushroom-grower in Great Britain, wrote to a friend in the United States that he marketed during the season of 1889–'90 11 tons of mushrooms, and during the season of 1890–'91 about 10 tons. In a meritorious treatise on "Mushroom culture for pleasure and profit," by Mr. William Falconer, of New Jersey, the author remarks:

In the most prosperous and progressive of all countries, with a population of nearly seventy millions of people alert to every profitable legitimate business, mushroom growing, one of the simplest and most remunerative of industries, is almost unknown. Mushrooms and their extensive and profitable culture should concern every one.

For home consumption they are a healthful and grateful food, and when successfully grown for market they become a most profitable crop. No one can grow mushrooms better nor more economically than the farmer. He has already the cellar room, the fresh manure, and the loam, and all he needs is some spawn with which to plant the beds. Nothing is lost. The manure, after having been used in mushroom-beds, is not exhausted of its fertility, but instead is well rotted and in a better condition to apply to the land than it was before being used for the mushroom crop. The farmer will not feel the little labor it takes. There is no secret whatever connected with it, and skilled labor is unnecessary to make it successful. The commonest farm hand can do the work, which consists of turning the manure once every day or two for about three weeks and then building it into a bed and spawning and covering it with mold. Nearly all the labor for the next ten or twelve weeks consists in maintaining an even temperature and gathering and marketing the crop.

Many women are searching for remunerative and pleasant employment on the farm, and what can be more interesting, pleasant, and profitable work for them than mushroom-growing. After the farmer makes up the mushroom bed, his wife or daughter can attend to its management with scarcely any tax upon her time and without interfering with her other domestic duties. And it is clean work; there is nothing menial about it. No lady in the land would hesitate to pick the mushrooms in the open field; how much less, then, should she hesitate to gather the fresh mushrooms from the clean beds in her own clean cellar. Mushrooms are a winter crop; they come when we need them most. The supply of eggs in the winter season is limited enough and pin-money often proportionately short; but with an insatiable market demand for mushrooms all winter long at good prices, no farmer's wife need care whether the hens lay eggs at Christmas or not. When mushroom-growing is intelligently conducted there is more money in it than in hens, and with less trouble.

MUSHROOM CULTURE.

The cellar of a dwelling house is a capital place for mushroom beds, and can be used in whole or in part for this purpose. In the case of private families who wish to grow only a few mushrooms for their own use it is not necessary to use the whole cellar; it will be sufficient to partition off a part of it with boards and make the beds in this, or to make a bed alongside of the wall anywhere and box it in to protect it from cold drafts and from mice and rats. Shelves may be placed above the bed for domestic purposes, just as in any other part of the cellar. Bear in mind that mushrooms thrive best in an atmospheric temperature of from 50° to 60°, and if you can give them this in your house cellar you ought to get plenty of good mushrooms. But if such a high temperature can not be maintained without impairing the usefulness of the cellar for other purposes, box up the bed tightly and from the heat of the bed itself when thus confined there usually will be warmth enough for the mushrooms, but if there is not, spread a piece of old carpet or matting over the boxing.

The beds may be made upon the floor, and flat or ridged or banked against the wall 10 or 12 inches deep in a warm cellar, and 15 to 20 inches or more deep in a cool cellar, and about 3 feet wide and any length to suit. The boxing may consist of any kind of boards for sides and ends, and be built about 6 or 10 inches higher than the top of the beds, so as to give the mushrooms plenty of head room. The top of the boxing may be a lid hung on hinges or straps, or otherwise arranged to admit of being easily raised or removed at will, and made of light lumber, say of half-inch boards. In this way, by opening the lid the mushrooms are under observation and can be gathered without any trouble. When the lid is shut they are secure from cold and vermin. Thus protected, the cellars can be ventilated without interfering with the welfare of the mushrooms. A light wooden frame covered with calico or oiled paper would also make a good top for the boxing, but would not be proof against much cold or against rats or mice. If desirable, shelf beds could be built in warm cellars above the floor beds, but in cool airy cellars this would not be advisable.

Manure beds in the dwelling-house cellar may seem highly improper to many people, but when rightly handled these beds emit no bad odor. The manure should be prepared away from the house, and when ready for making into beds should be spread out thin, so as to become perfectly cool and free from steam. When it has lain for two days in this condition it may be brought into the cellar and made into beds. Having been well sweetened by previous preparation, it is now cool and free from steam, and almost odorless. After a few days it will warm up a little, and may then be spawned and earthed over at once. Do not bury the spawn in the manure; merely set it in the surface of the manure. This method prevents the spawn from being destroyed by too great heat, should the bed become unduly warm. If the manure has been well prepared, however, this is not likely to occur. The coating of loam prevents the escape of any further steam or odor from the manure.

On the 14th of January last Mr. W. Robinson, editor of the London Garden, in writing to me mentioned the following very interesting case of growing mushrooms in the cellar of a dwelling house:

I went out the other day to see Mr. Horace Cox, the manager of the Field newspaper, who lives at Harrow, near the famous school. His house is heated by a hot-water system called Keith's, and the boiler, which is a very simple one, is in a chamber of the house in the basement. I went down to see it worked with coke refuse. However, I was pleased to see all the floor of the room not occupied by the boiler covered with little flat mushroom-beds and bearing a very good crop. Truth to tell, I used to fear that growing mushrooms in dwelling houses might be objectionable in various ways, but this instance is very interesting, as there is not even the slightest unpleasant smell in the chamber itself. The beds are small, scarcely a foot high, and perfectly odorless, so that it is quite clear that one may cultivate mushrooms in one's house in such a case as this without the slightest offense. A bed has been known to begin bearing early in November and to bear a good crop until the first of May. Mr. Denton, a market gardener about 10 miles from New York on Long Island, uses both French and brick spawn. He markets from 1,700 to 2,500 pounds of mushrooms a year from his two cellars. Every summer he cleans out his cellars and lime-washes them all over. He ascribes his success to thorough cleaning.

GLOSSARY OF TERMS USED IN DESCRIBING MUSHROOMS.

Acaulescent, with a very short stem, apparently none.
Acetabuliform, shaped like a cup.
Adnate, gills firmly attached to the stem.
Adnexed, gills just reaching the stem.
Alveolate, socketed or honeycombed.
Amphigenous, when the hymenium is not restricted to a particular surface.
Anastomose, the joining of one vein with another; branching.
Annular, having the form of a ring.
Annulate, ringed, or with the appearance of a ring.
Annulus, ring, round the stem of Agarics.
Arachnoid, cobweb-like in structure or appearance.
Asci, spore-cases.
Ascending, directed upwards.
Ascidia, spore-cases of certain fungi.
Attenuate, tapering gradually to a point, upward or downward.
Basidia, cellular processes of certain mushroom-bearing spores.
Bossed, furnished with a boss. (*See also* Umbonate.)
Bulbous, with the structure of a bulb.
Cæspitose, growing in tufts.
Campanulate, bell-shaped.
Canaliculate, channeled.
Cap, the pileus of a mushroom.
Capillitium, threads of puff-balls.
Carious, decayed.
Cartilaginous, hard and tough.
Channeled, hollowed out like a gutter.
Chlorosis, loss of color.
Cilia, marginal hair-like processes.
Ciliate, fringed with hair-like processes.
Clathrate, latticed.
Clavate, gradually thickened upwards.
Club-shaped. (*See* Clavate.)
Cortinate, cobweb-like in texture.
Connate, as when two or more pilei become united.
Cratera, a cup-shaped receptacle.
Crenulate, notched or scalloped.
Cryptogamia, a term applied to the division of nonflowering plants.
Decurrent, when the gills of an Agaric are prolonged down the stem.
Dentate, toothed.
Distant, applied to the gills of Agarics when far away from each other.
Dimidiate, applied to the gills of Agarics when they proceed only half way to the stem.
Echinate, furnished with stiff prickles.
Emarginate, applied to the gills when they are notched or scooped out before reaching the stem.
Excentric, out of center.
Farinose, covered with a white mealy powder.
Favose, honeycombed.
Fibrillose, covered with loose fibers.

Fimbriated, fringed.
Fistular, Fistulose, tubular, closed at each end in the case of mushrooms.
Flexuose, wavy.
Floccose, covered with hairs which fall away in tufts.
Foveolate, pitted.
Free, not adhering nor adnate; used in relation to the gills of mushrooms.
Fructification, reproductive parts of a plant.
Fugaceous, falling off rapidly.
Funnel-shaped. (*See* Infundibuliforme.)
Gills, vertical plates radiating from the stipe on the under surface of the pileus of mushrooms.
Glabrous, smooth.
Globose, nearly spherical.
Habitat, natural abode of a plant.
Hirsute, hairy.
Hymenium, the part of mushrooms on which spores are borne; the fructifying surface.
Hymenophorum, the structure which bears the hymenium.
Hypogœous, subterranean.
Hygrophanous, looking watery when moist and opaque when dry.
Imbricate, overlapped like tiles.
Infundibuliforme, funnel-shaped.
Inferior, growing below, as when one organ grows below another.
Involute, with the edges rolled inwards.
Lacunose, pitted or having cavities.
Lamellæ, the gills of mushrooms.
Lepiota (from the Greek word meaning *a scale*), the annulus of some fungi.
Lateral, attached to the side.
Linguiform, shaped like a tongue.
Marginate, having an edge of a different texture to the body, so as to form a distinct border.
Matrix, any body upon which a fungus grows.
Mycelium, the spawn of fungi.
Netted, covered with projecting reticulated lines.
Obtuse, blunt or rounded.
Pallid, a pale and undecided color.
Paraphyses, jointed threads found with the reproductive organs of some plants.
Papillose, covered with soft tubercles.
Parasitic, growing on and deriving support from another plant.
Pedicel, foot-stock.
Pedicellate, having a pedicel.
Pectinate, toothed like a comb.
Peridium, general covering of a puff-ball.
Pileate, having a cap or pileus.
Pileus, the cap of a mushroom.
Pilose, hairy.
Pits, depressions in cells or tubes resembling pores.
Plumose, feathery.
Powdery, covered with bloom or powder.
Pubescent, downy.
Pulverulent, covered with dust.
Pulvinate, like a cushion.
Remote, when the margin of the gill comes to an end before reaching the stem.
Rugose, covered with wrinkled lines, the interspaces being convex.
Resupinate, inverted by twisting of the stalk.
Scabrous, rough.
Scrobiculate, marked with little pits or depressions.
Semi, half.
Serrate, toothed like a saw.
Sessile, without a stalk.
Sinuate, with a waved margin.
Species, a group of individuals without deviation from each other, except such as might result from accidental circumstances.
Spheroidal, nearly spherical.
Spores, the reproductive bodies of cryptogams analogous to seeds.
Sporidia, reproductive cells.
Sporophores, cells surmounted by fertile spicules.
Squamose, scale-like, scaly.
Squarrose, rough, with projecting or deflexed scales.
Stem, the ascending axis of plants.
Stigmata, points of the basidia of some mushrooms.
Stipe, stem of mushrooms.
Striated, streaked with longitudinal lines.
Strigose, covered with sharp rigid hairs.
Stuffed, filled with a spongy mass; applied to stems of mushrooms.
Sulcate, furrowed.
Tomentose, downy with short hairs.
Torsive, twisted spirally.
Torulose, when a cylindrical body is swollen and restricted alternately.
Trama, the substance intermediate between the hymenium in the gills of Agarics or pores of Polyporei.
Tremelloid, jelly-like in substance.
Tubular, hollow and cylindrical.
Turbinate, top-shaped.
Umbonate, furnished with a boss.
Umbo, a central elevation like the boss of an ancient buckler.
Umbilicate, having a central depression.
Veil, in mushrooms, partial covering of the stem or margin of the cap.
Verrucæ, warts or glandular elevations.
Verrucose, covered with warts.
Villose, covered with long weak hairs or down.
Volute, rolled up in any direction.
Volva, a general wrapper in mushrooms, sometimes membranous, sometimes gelatinous.
Wart, a firm glandular excrescence on the surface. (*See* Verrucæ).

EXPLANATION OF PLATES.

PLATE II.—AGARICUS MELLEUS, Vahl. (Order *Agaricini.*)

(Edible.)

Subgenus ARMILLARIA (Little Bracelet). Veil partial, annular, hence the name from armilla, an armlet or bracelet, alluding to the ample persistent collar of the plant. Described by Bulliard as *Agaricus annularis*, by Decandolle as *A. annularius*, by Persoon as *A. polymyces*.

Cap fleshy, honey-colored or ocherous, striated on the margin, shaded with brown, darker towards the center, umbonate or umbilicate in full-grown specimens, tufted with dark-brown fugitive hairs. Color of cap varies, depending upon climatic conditions and the character of the soil. Gills distant, ending in a decurrent tooth, pallid or dirty white, very often showing brown or rust-colored spots when old. Spores white and abundant. Stem elastic, scaly, 4 inches or more in length. Ring floccose. Diameter of cap from 2 to 5 inches. Manner of growth cæspitose, and, as with most of the Armillarias, generally parasitic on old stumps, although I found the group here figured growing on moist sandy clay on a roadside in Hyndsbury Park, Md.

PLATE III.—AGARICUS DELICIOSUS, Fr.

(Edible.)

Subgenus LACTARIUS (milk-bearing). Hence the name, from *lac*, milk, applied to the exudation from the gills, which in some of the species resembles cows' milk. Deliciosus refers to the agreeable flavor of the plant, which is one of the most remarkable of this group.

Cap fleshy, hemispherical, then convex umbilicate in some adult specimens, funnel-shaped, marked in the adult plant with rings or zones of a ferruginous color. Color of the cap orange, varying in tint, growing paler and greenish when old or dried. Diameter from 2 to 6 inches. Gills decurrent, crowded, rather thick, sometimes slightly forked at the base, according to some French writers on mushrooms. Color of the gills pale orange, sometimes a saffron yellow, exuding when bruised a bright red or orange colored liquid, hence often given the name, popularly, of the "orange-milk" mushroom. This liquid turns green on exposure to the atmosphere. Stem attenuated downward, smooth, and stuffed with a yellowish pith, then hollow, and finally brittle. Color about the same as the cap.

PLATE IV.—CANTHARELLUS CIBARIUS, Fr.

(Edible.)

This species is distinguished from an Agaric, which at first sight it resembles, by having veins instead of gills. It has been described by Linnæus as *Agaricus cantharellus*, by Bulliard under the same name, by Scopoli as *Merulius cantharellus*. Fries does not put it in the list of Agaricini, while Berkeley classifies it under that order. The chantarelle takes its name from a Greek word signifying a cup or vase, referring to its shape and possibly also to its rich golden color. Cibarius refers to its esculent properties.

Cap a rich egg yellow, at first convex, later concave and turbinated. Margin sinuous-undulate, smooth and more extended on one side than the other. Diameter nearly 4 inches. Veins rather thick and wiry, markedly decurrent, usually bifurcated 2 or 3 times, and of the same color as the cap. Spores white. Stem stuffed, thicker above, tapering downward, and slightly curved at the base. Flesh white and firm, odor agreeable, flavor a little peppery. Found in the woods in groups in summer and in autumn.

PLATE V.—FISTULINA HEPATICA, Fr. (Order Polyporei.)

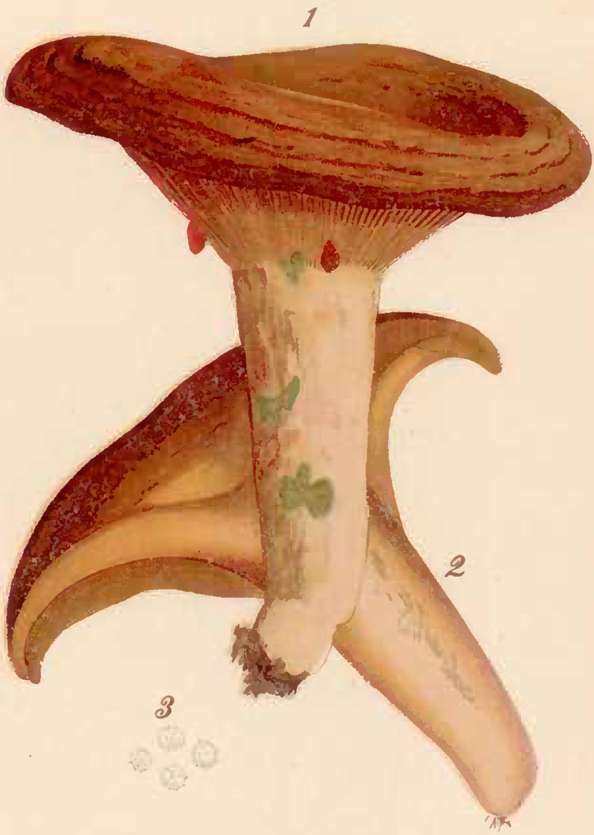
(Edible.)

Fistulina refers to the form of its little tubes situated on the under surface of this mushroom, *hepatica* to its fancied resemblance when old to a piece of liver. It is also called by the French, Langue de Bœuf, beef's tongue, which it sometimes resembles, when young, in shape and color.

Cap of variable form, upper surface at first, blood-red, covered with papillæ, then

AGARICUS (ARMILLARIA) MELLEUS.
Group from Hynesboro Park, Md., U.S.

K. MAYO, del.



AGARICUS (LACTARIOUS) DELICIOSUS.
1 General form. 2 Section 3 Spores.

Sackett & Wilhelms Lithographing Co. New York

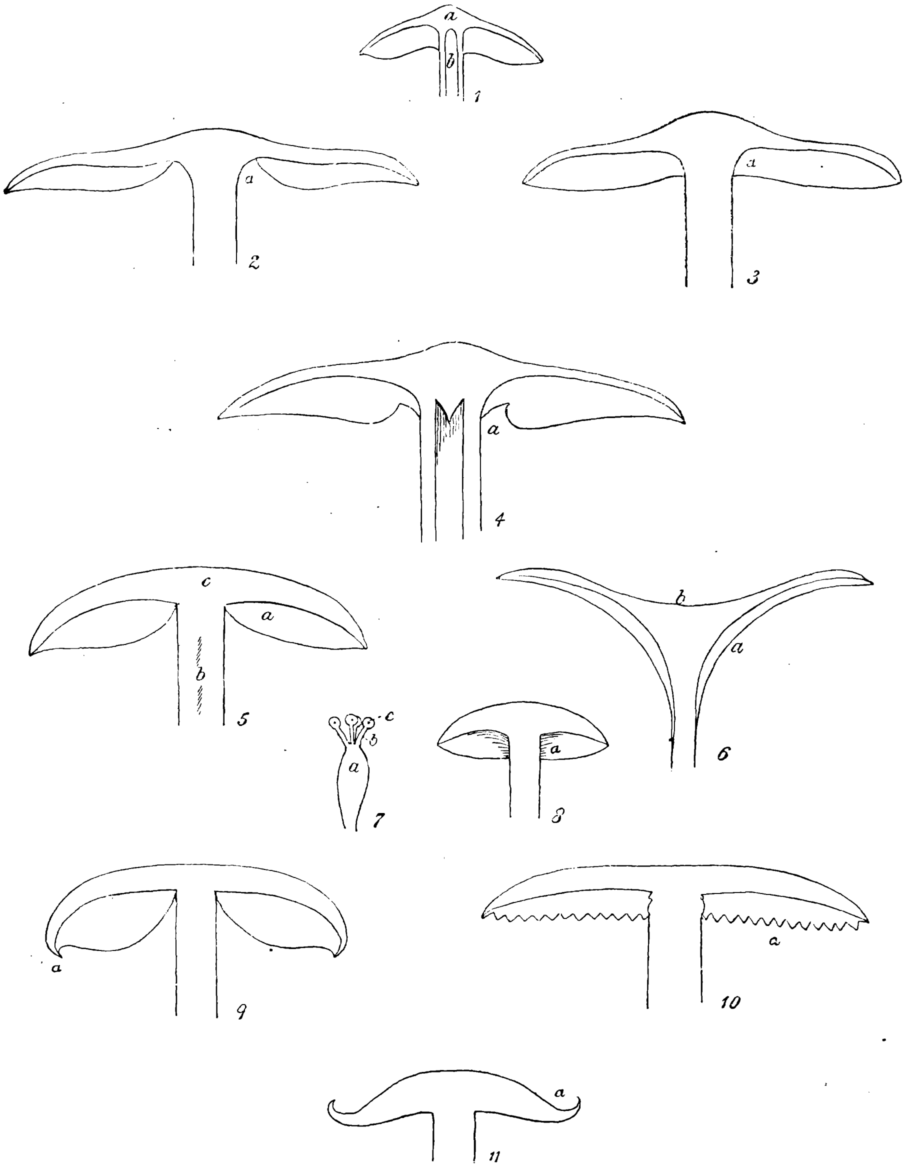
CANTHARELLUS CIBARIUS FR.
1, 2, 3, 4, Various stages of growth 5 A section.
6 Spores 7 Spores and basidia.
From Hynesbury, Md., U.S.

K. MAYO, del.

FISTULINA HEPATICA.

1 Specimen, upper view. 2 Same, under view.
3 Specimen, upper view. 4 Same, under view.
5 Spores.

K. MAYO, del.



SECTIONS OF MUSHROOMS.

W. Scholl, del.

red-brown, and finally a very dark red. Flesh fibrous, juicy, and mottled. Flavor acid, odor agreeable. Tubes at first short, then elongated, having fringed orifices, color whitish, turning brown when bruised. Sometimes found of quite large size. One is mentioned as found in England weighing 30 pounds. Found in summer and autumn on oak and beech trees principally. In Italy its common name is said to be "oak tongue" or "chestnut tongue," and it is said to be equally good whether gathered from one or the other.

This mushroom is described by Schaeffer as *Boletus hepaticus;* Bulliard gives it as *Fistulina buglossoides.* Berkeley describes a "beautiful and interesting species, *A. (Pleurotus) subpalmatus,* Fr.," as having the flesh mottled like that of *Fistulina hepatica,* and also gives the habitat of *Polyporus quercinus* as identical with the species represented in Plate v. Figs. 1, 2, 3, and 4 of this plate represent the color and form of the upper and under surfaces of specimens collected near Falls Church, Va., where the species grows in profusion.

For most beautiful specimens of this and many other of our native mushrooms, I am indebted to Dr. F. J. Braendle, Falls Church, Va.

PLATE VI.—STRUCTURE OF THE GILL-BEARING MUSHROOMS.

Fig. 1. Cap or pileus umbonate, *a*; stem or stipe fistulose, *b*; gills or lamellæ adnate and slightly emarginate.
Fig. 2. Gills remote, *i. e.*, distant from the stem. (See *a*.)
Fig. 3. Gills adnexed, partly attached to the stem at their inner extremity *a*.
Fig. 4. Gills emarginate, with a tooth, as at *a*, stem stuffed.
Fig. 5. Cap obtuse, *c*; gills free, *i. e.*, reaching the stem but not attached thereto. (See *a*.) *b*, stem, stuffed.
Fig. 6. Cap umbilicate, *b*; gills decurrent, *i. e.*, running down the stem. (See *a*.)
Fig. 7. Basidium cell, *a*, borne on the hymenium or spore-bearing surface of the gills; *b*, stigmata; *c*, spores.
Fig. 8. Gills adnate, *i. e.*, firmly attached to the stem at their inner extremity, as at *a*.
Fig. 9. Cap with border involute, *i. e.*, rolled inward. (See *a*.)
Fig. 10. Lamellæ or gills dentated or toothed. (See *a*.)
Fig. 11. Cap with border revolute, *i. e.*, rolled backward. (See *a*.)

MECHANICAL DEVICES PERFECTED DURING THE YEAR.

REVOLVING STAGE FOR VIEWING MICROSCOPIC SECTIONS, ETC.

[Plate VII.]

This plate exhibits a view of a new and improved form of revolving brass plate which I have recently devised in order to supply a need long felt in the division. It may be attached to any microscope, and is designed principally for reviewing and comparing serial sections and textile fibers. This revolving plate is pivoted upon the substage by means of a downward-projecting pin. It may thus be rotated freely at the pleasure of the operator. Slides mounted with subjects for investigation and comparison are secured by means of spring clips upon the surface of the plate.

A stage of this description which I am accustomed to use exhibits eleven different samples of wools. In jury trials relating to wools I have found it sometimes desirable to have six microscopes in use at one time in illustrating the respective characteristics of various samples of wool. Even with this number the parties are seldom satisfied, as one person is obliged to move from one instrument to another, interfering perhaps with the view of other observers. The system I have initiated saves much time—an important consideration in the court room. By means of the revolving plate, eleven diverse samples may be compared in less time than an observer could move from one microscope to another.

Six stands of this model were on exhibition at the fourteenth annual meeting of the American Microscopical Society, recently held in this city,

and the invention gave universal satisfaction. The publishing committee of the society have requested a description of this plate for the forthcoming volume of proceedings.

I use a similar form for high powers, consisting of perfectly clear glass 2 millimeters in thickness, circular in form like the preceding, and, like it, attachable to the plane stage of a microscope. On this plate the objects may be arranged upon its margin, the same as on the usual glass slides, and the cover-glass fixed upon them, thus dispensing with clips, which interfere somewhat with the objective when using high powers. Or the plate may be perforated, as in the metal plate, the mounts fixed by means of wax or a drop of paraffine at the edges of the slides. This method, I find, renders the object sufficiently steady for examination, and the wax has the advantage of being easily removed when it has answered the purpose, leaving a clean plate for change of subject or for further investigation. The diameter of the revolving plate is only limited by the construction of the microscope stand, to which it is an adjunct.

MACHINE FOR TESTING THE TENSILE STRENGTH OF VEGETABLE FIBERS AND THREAD.

[Plate VIII.]

Plate VIII, Fig. 1, represents the Taylor Machine No. 1 for testing the tensile strength of textile fibers, such as flax, cotton, ramie, silk, etc., used in the manufacture of the various threads.

In applying this machine, one end or thread to be tested is secured by means of wax* to the small brass knob *b* of spring *a*. The other end of the fiber or thread is secured to a similar brass knob *c* attached to the rod *d*, to which a rectilinear motion is communicated by means of a screw *e* and wheel *f*, corresponding to the plane of the spring and the fiber. On revolving the wheel the thread is stretched until it breaks; *g* is a scale underneath the fiber or thread between the points of connection of the thread with the spring and rod. Fig. 2 is a full-size view of this scale; *h* represents a metal block which is moved forward on the scale by means of a drive-pin attached to the spring and projecting downward from it. When the thread breaks, the block *h* remains stationary at the point to which it has been moved forward with the stretch, indicating on the scale the breaking strain in pounds or fractions thereof to which the fiber or thread has been subjected. Scale *i*, shown on the semicircular plate, over which an index is mechanically moved as the wheel revolves, registers in a higher degree the tension to which the thread has been subjected before breakage. A is a device for ascertaining the weight value of the spring used in the machine, which should be always ascertained in advance and the spring then placed in position in the machine, as above. The spring suspended, as represented at A, is weighted to any amount desired, and its extension, corresponding to such weight, will be registered on the graduated scale *g'*, which corresponds with scale *g* of the machine already described.

The subjoined table gives the results of eighty preliminary tests on this machine of four samples of foreign flax thread, *i. e.*, Courtrai, Dutch, Irish, and Russian, twenty tests of each having been made separately.

* In testing the tensile strength of fibers it is found in practice that the respective ends of the fiber or thread should be secured by twisting each end several times round a knob, painted with a composition of beeswax, instead of securing the ends with a knot, since a thread has a great tendency to break at a knot.

These samples were in separate parcels, each marked with the market value of the fiber per ton: Courtrai, \$367.84; Dutch, \$306.60; Irish, \$266.20; Russian, \$193.60.

Fiber.	Size of thread.	Minimum breaking strain.	Maximum breaking strain.	Average.	Total of 20 fibers.
		Pounds.	*Pounds.*	*Pounds.*	
Courtrai	40s	1.375	3.6666	2.7797	55.549
Dutch	40s	1.375	3.2083	2.2229	44.458
Irish	40s	1.375	3.6666	2.0277	40.454
Russian	40s	1.604	2.9792	1.9937	39.874

Second experiment.

Fiber.	Minimum breaking strain.	Maximum breaking strain.	Average.
	Pounds.	*Pounds.*	*Pounds.*
"50 line." (This is the product of 70 pounds of dressed flax, giving 60 pounds of linen yarn, which, spun as per sample, will measure 940,000 yards.)	1.459	2.0625	1.5927
"25 tow." (The product of 27 pounds of tow, giving 22 pounds of this yarn, which, spun to this sample, will measure 165,000 yards.)	1.4896	5.2708	2.3949

NOTE.—Both these samples, "50 line" and "25 tow," were produced from 100 pounds of raw flax, on which there was a loss in the process of manufacture of 3 pounds. "Line" means a thread or yarn which has been spun from dressed flax only, in contradistinction to "tow" yarns, which are made from tow alone.

"40s" is used to designate the size of the thread, and means that in 1 pound weight of that yarn there are 40 leas or cuts, each lea or cut containing 120 threads of $2\frac{1}{2}$ yards each, so that 1 pound of 40s yarn should contain 40 leas, giving 4,800 threads, equal to 12,000 yards in all. "50 line," on the other hand, would give to 1 pound of yarn 50 leas, equal to 6,000 threads, or 15,000 yards. "25 tow" will give to 1 pound weight 25 leas, equal to 3,000 threads, or 7,500 yards, and other numbers in proportion. In the second experiment here given the tests were made, probably, from samples containing a mixture of each of the different classes of raw flax, this being a method of manufacture frequently adopted by spinners in order to obtain the best results for a certain price.

The London prices during December for yarns spun from the different classes of flax mentioned in the table were as follows:

Per 60,000 yards.

	s	*d.*
Courtrai	4	11
Dutch	4	8
Irish	4	6
Russian	4	5

It will be noticed how closely these prices coincide with the relative strength value of the fibers, as determined by the tests. While the flexibility, evenness, and superior brilliancy of some flaxes commend them for special purposes, it is evident that for the farmers' uses, for binder twine, cordage, etc., the tensile strength of the fiber constitutes its greatest commercial value and is the most important object of investigation.

MACHINE FOR TESTING BINDER TWINE.

(Plate IX.)

By the use of this machine (Taylor machine No. 2), farmers' binder twine or small cord may be tested quickly, and the relative strength of samples of either ascertained.

The groundwork of the machine consists of iron and steel, of which

Plate IX, Fig. 1, illustrates a top view; *a a*, bed of the machine; A, Fig. 2, section of *a a; h h*, slide-bearings on surface of the machine bed; *b*, operating wheel of screw *c; d* and *e*, journal-boxes, both stationary. The screw *c* passes through a movable framework consisting of *g g'* and connecting rods *f f; i*, a collar on shaft of screw *c* in box *e; g g* is the only journal-box furnished with a screw thread, consequently on the revolution of the screw the frame *g g' f* is set in motion, since the screw has no lateral motion.

To operate the machine, turn the screw until box *g g* touches stationary box *e*. One end of the cord or twine to be tested is passed through the opening at *w*, to *t*, where it is twisted over pins on top of *g g'*. The other end of the cord or twine is passed through a moveable frame *u*, and secured in position at *m*. A steel spring *o*, 5 inches in diameter, supported by an iron cylinder, passes through a rubber spring *q*, or its equivalent, and is secured by nut *v; n* and *q* are springs which receive the recoil of the large spring *o* when the cord breaks. Countersunk in slide-bearing *h* is a stationary scale *y*, and over it a movable scale-bar *j*. On frame *u*, at *z*, is a projection for the purpose of pushing to the left the scale bar *j*, which uncovers scale *y* as the screw is rotated to the right. On the cord being stretched, an index *s*, secured on a movable rod *s'*, which in turn is secured to frame *g'*, and movable with it, registers the stretch, up to the breaking point, in inches and fractions thereof. Scale *y* comes into view in proportion to the movement of the scale bar *j* to the left. As the end of scale bar *j* resting on scale *y* is filed to a thin edge, it becomes the index of scale *y*, showing the breaking strain in pounds and fractions thereof.

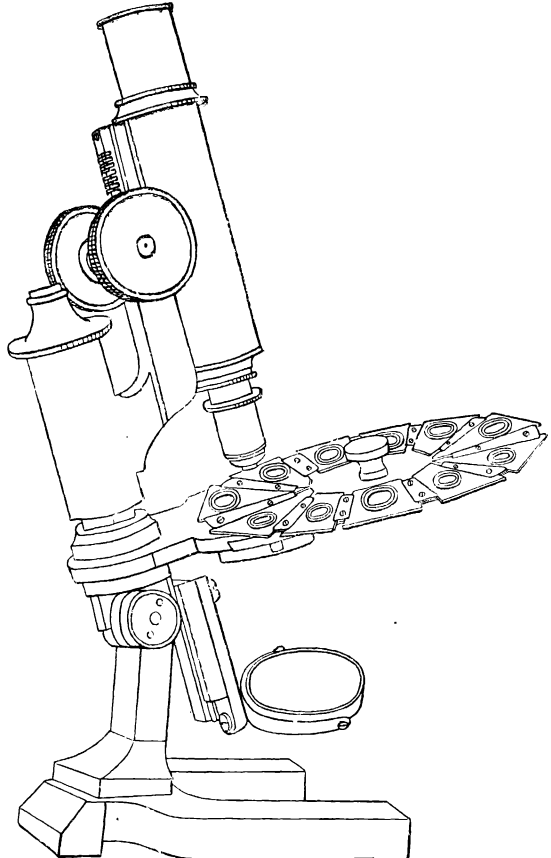
The subjoined table gives the results of a given number of preliminary tests by this machine of a sample of farmers' binder cord of Manilla hemp.

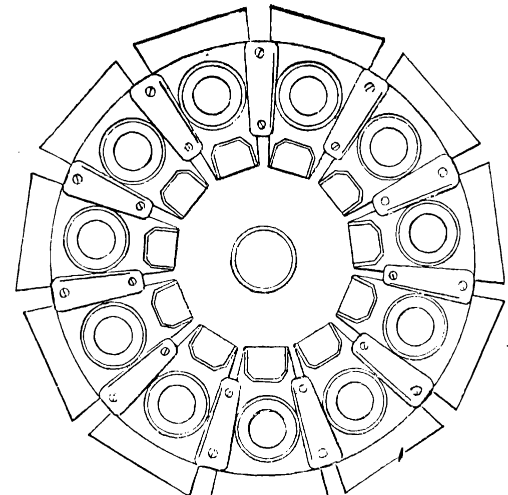
Tests of a sample of farmers' "binder twine" made of Manilla hemp.

No. of test.	Breaking strain.	Stretch.	No. of test.	Breaking strain.	Stretch.
	Pounds.	*Inches.*		*Pounds.*	*Inches.*
1	72.5	1.6875	9	55	1.375
2	40	1.5	10	60	1.375
3	75	1.375	11	80	1.625
4	60	1.25	12	70	1.25
5	100	1.625	13	80	1.5
6	50	1.75	14	55	1.25
7	75	1.25			
8	55	1.25	Average	66.25	1.433

Report of the Microscopist, U. S. Department of Agriculture, 1891.

PLATE VII.





MICROSCOPE WITH REVOLVING STAGE.

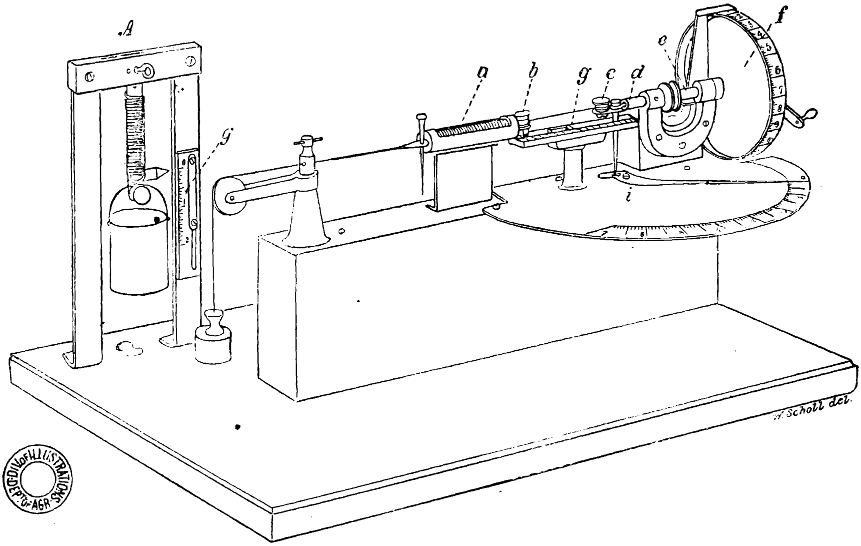


Fig. 1.

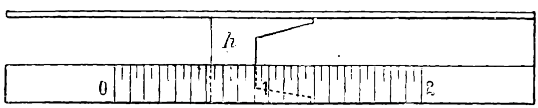


Fig. 2.

MACHINE FOR TESTING TENSILE STRENGTH OF TEXTILE FIBERS.

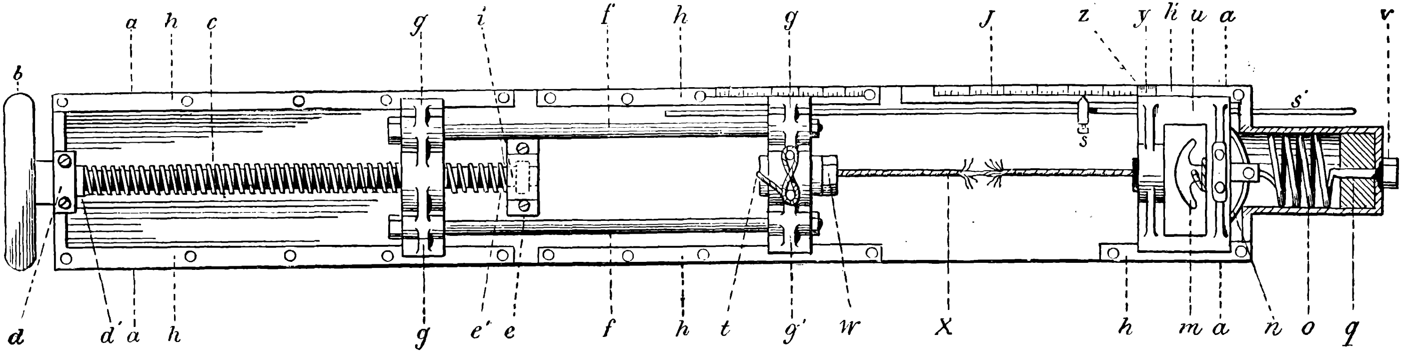


Fig. 1.

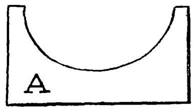


Fig. 2

MACHINE FOR TESTING BINDER TWINE.

Report of the Microscopist, U. S. Department of Agriculture, 1891.

REPORT OF THE SPECIAL AGENT IN CHARGE OF THE FIBER INVESTIGATIONS.

SIR: I have the honor to present herewith a report upon the investigations of the Department during the past year relating to the culture of Sisal hemp in Florida and flax culture in the Northwest.

Respectfully submitted,

CHAS. RICHARDS DODGE,
Special Agent.

Hon. J. M. RUSK,
Secretary.

THE SISAL HEMP INDUSTRY IN FLORIDA.

Pursuant to your instructions, I visited Florida early in the year, making a personal fiber survey of the entire coast line of the southern peninsula, from Jupitér Inlet on the east coast to Charlotte Harbor on the Gulf, including explorations of the principal keys, occupying several weeks of time.

The fact that the Sisal hemp plant can be grown in this country in any quantity, as far as the mere question of cultivation is concerned, was satisfactorily demonstrated many years ago. Over fifty years have passed since the plant was introduced into Florida by Dr. Henry Perrine, and it is now growing wild in many portions of the State. The history of the introduction of the plant and the story of the tragic ending of that unfortunate enterprise are almost too well known to repeat here. It has been my good fortune, however, to obtain from Mrs. Hester Perrine Walker, of Fernandina, Fla., a daughter of the doctor, and an eye-witness of the Indian Key massacre, some interesting statements, from which the following facts are gleaned.

Mrs. Walker informs me that the first introduction of the plant from Yucatan occurred in the years 1836 and 1837, a few plants having been sent to the royal botanical gardens of Cuba at the same time. Of the plants brought to Florida, part were taken to Indian Key and the others were planted upon "the Indian hunting ground," on the borders of Biscayne Bay. It is also stated that when these plants had multiplied to some extent the officers at Fort Dallas, at the mouth of the Miami River, 12 miles from this locality, were in the habit of gathering the young ones to send to greenhouses in the North, and also to other posts, where they were grown as ornamental plants. One of the results of this practice was to introduce the plant into many new localities in Florida, where it soon obtained a foothold. The plants set out on Indian Key multiplied very fast, and a few years after the destruction of the enterprise and the death of Dr. Perrine, at the time of the Indian

massacre, a schooner load of the young plants was gathered and taken away, though it is not stated where they went. Many other plants were introduced at the same time, among them other species of Agave, in all some 200 varieties, which were growing in boxes on the premises of Dr. Perrine and Mr. Howe, Indian Key, preparatory to the removal to the "grant" as soon as the war should cease. These were nearly all burned or destroyed at the time of the massacre, August 7, 1840.

The plants when introduced upon the mainland spread rapidly, being commonly transplanted to the gardens of the early settlers of south Florida chiefly for the sake of ornament. In 1842 the armed occupation act was passed by Congress, which gave a homestead of 160 acres to any person who occupied a tract five years. One of the results of this act, as I am informed by Mr. Ranson, of Titusville, was the planting out of small patches of Sisal hemp by the heads of families settling on the Indian River in the neighborhood of Fort Capron.

These facts are considered worthy of mention, as showing that while every other evidence of former cultivation has long since disappeared, the Sisal hemp, regardless of forest fires, weeds, and neglect, still holds its own and spreads year by year.

I may mention that the imports of Sisal hemp fiber into this country from Yucatan for the fiscal year ending June 30, 1890, amounted to 28,312 tons, in round numbers, worth $4,330,300, and for the year previous the imports amounted to over 35,000 tons. This does not take into account the imported manufactures from Sisal hemp, which are considerable, the value of which can not be given. It is said that the United States purchases over 80 per cent of the marketable fiber produced in Mexico. In 1845 the export of fiber from Mexico amounted to a little over $100,000, and in 1869, according to Squier, the imports into the United States amounted to less than $34,000. It is only in very recent years, therefore, comparatively speaking, that this industry has become important.

From a report on the industries of Mexico, published for distribution at the Paris Exposition of 1889, we learn that prior to 1854 Sisal hemp was only exported after manufacture into hammocks, cordage, etc. The whiteness and pliability of these attracted the attention of foreign dealers, and the United States began to import the raw material. Yucatan producers were then forced to make their products known to European markets. They succeeded so well that the exportation of henequen, which in 1880 was estimated at 2,173,468 piasters, attained in 1887 to 1888 the sum of 6,641,255 piasters.

At the present time not only is the fiber produced to an enormous extent in Mexico, but Cuba and the Bahamas are interested in its production, with a promise of practical results. What can be done in the Bahamas I have reason to believe can be accomplished in this country, with intelligent effort and attention to small details at the outset to avoid costly mistakes. We have the soil, the climate, and the plants. The combination of capital and inventive genius, with these conditions, must work out the problem, if indeed the question is not already practically solved. Already capitalists have made a beginning on New River, between Lake Worth and Biscayne Bay, by the purchase of a large tract of land, a portion of which has already been planted. There is considerable inquiry in relation to the subject, and a prospect of the early formation of other companies, in addition to the interest shown by private parties in the industry.

While the literature of the subject is extensive, the published records covering a period of fifty years or more, the chief sources of informa-

tion, and especially in regard to the botany of the Sisal hemp plant, are the descriptions given by Dr. Perrine in Senate Document No. 300, bearing date March 12, 1838, being a report* to accompany Senate bill No. 241, and a valuable contribution on the subject of the "Jenequen" by Dr. Schott, and published in the Annual Report of the Department of Agriculture for 1869. In the transactions of the St. Louis Academy of Science, Vol. III, December, 1875, the statements and conclusions of these two observers are reviewed at length. In the bulletin of the Royal Gardens, Kew, for March, 1877, there is another important article, in which the botanical considerations are fully treated.

The common names applied to the fiber are Sisal hemp, Mexican grass, grass hemp, *Henequen* or *Jenequen*, *Sosquil*, and *Cabulla* or *Cabuya*, the latter being the Central American names.† While Dr. Perrine recognizes the several forms, all of which in his opinion "merit to be transplanted to Cape Florida," and records at the same time that "the *yashqui* species of henequen yields the best quality of foliaceous fibers and the *sacqui* the greatest quantity," he nevertheless refers chiefly to the "*yashqui*" (*yaxci*) in his arguments in favor of the introduction and cultivation of the henequen in Florida, and Dr. Engelmann states that this is the form introduced into Florida.

This is the *Agave rigida sisalana*, the leaves of which are described as "pale green but glaucus, 4 to 6 feet long and 4 to 6 inches wide, generally smooth-edged, but here and there having a few unequal sometimes very stout and sharp teeth." It is considered to be "the most valuable of the fiber-producing agaves."‡

I found no leaves wider than 5¼ inches, 5 inches wide being the common measurement; and, save in rare instances, the leaves were entirely devoid of spines along their edges, although the terminal spine is always present.

The spined form is a different variety, probably the *A. rigida longifolia*, having a stockier habit, the leaves being somewhat lighter in color, the distinguishing feature being the row of heavy spines or barbs

*The introduction reads: The Committee on Agriculture, to whom was referred the memorial of Dr. Henry Perrine, late American consul at Campeachy, praying for a conditional grant of land in southern Florida to encourage the introduction and promote the cultivation of tropical plants in the United States, have had the same under consideration, and beg leave to submit to the consideration of the Senate the following report.

†The native names of the seven species or varieties of plants recognized in Yucatan as producing henequen are enumerated by Dr. Schott as follows: (1) The *chelem* (or tshelem), which grows spontaneously over the country, finding its favorite range on the barren rocky districts of the northwest, with their border of maritime sand flats, thought to be *Agave angustifolia*. (2) The *yaxci* (or yaashki), with shorter leaf, of bright velvety green, produces less fiber, but excelling in softness, flexibility, and luster, and bringing a higher price in the market. Its cultivation is limited to the more genial soil and climate of the eastern and northern parts of the peninsula. (3) The *sacci* (saci or saqui), meaning white agave, which, while cultivated throughout Yucatan, appears to have its center of production in the northwestern part, or the district of Merida. It produces a far greater quantity of fiber than the preceding, and furnishes the principal bulk of that exported. These two forms may be said to produce the Sisal hemp of commerce. The leaves of the *sacci* are easily recognized by the wax-like bloom with which they are covered. (4) The *chucumci* (or tshucumki), resembling No. 3, though yielding a harder, rougher, and naturally inferior fiber, thrives best on the rocky flats and sandy regions near the coast. (5) The *babci* (babki or vavki), quite distinct from No. 3, of quicker growth, and producing twice as many leaves, but of smaller size, and therefore less profitable. (6) The *citamci* (or kitamki), with short, narrow leaves, and producing poor fiber. This species is thought to come nearest to the wild plant. (7) The *cajun* (or cahun), like the first on the list, an indigenous species growing spontaneously along the border of the mangrove region, can probably be referred to *Furcræa cubensis*.

‡Dr. Engelmann, Report St. Louis Academy of Science, previously referred to.

with which the edges of the leaves are armed. This is the Mexican form, and whether the absence of spine in the common Florida form is due to change of climate and other conditions or not is an interesting question. From the fact that some smooth-leaved plants show here and there a leaf or part of a leaf with spines would favor the idea of modification by change of conditions.

Plate I illustrates the appearance of a living plant of *Agave rigida sisalana*, from a photograph taken at Jupiter.

The first point of interest in my investigation in Florida was Titusville, where thrifty plants were seen in the gardens, grown chiefly for ornament. At Cape Canaveral, on the coast, Mr. Robert Ranson has a small plantation, which was doing well. This, I should say, was the northern limit of Sisal culture, but in my opinion the best results will be obtained below Jupiter and the Lake Worth district. The most interesting tract visited along this portion of the coast was found on the point perhaps a mile below the railroad station and wharf at Jupiter. Here I found a thicket of these agaves, both the smooth and spined varieties, many of the plants having shot up their "poles" or flower stalks, which were covered with blossoms and young plants. Mr. John Cleminson has a small plantation not far from this tract, and a mile or two above Jupiter I visited, with Mr. John H. Grant, a nursery of small plants, which were in a flourishing condition.

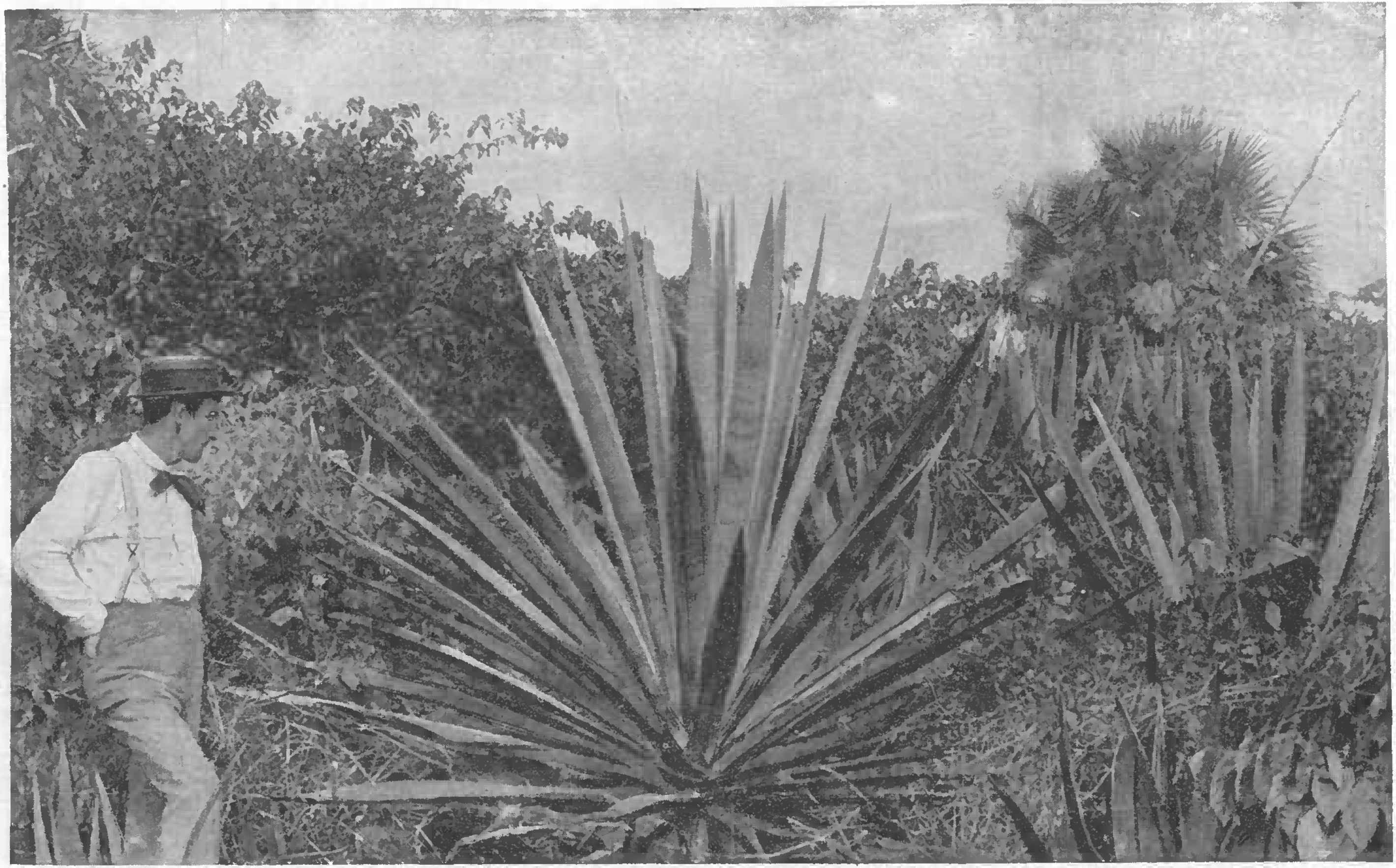
At Juno, about 10 miles farther south, at the head of Lake Worth, I found another fine nursery, the property of Mr. A. M. Fields, who is quite enthusiastic on the subject. At the time of my visit the Florida Fiber Company, located at New River, was just breaking ground, and their tract was not visited.

The Biscayne Bay region is undoubtedly the most favorable locality for Sisal hemp cultivation. I discovered the plant growing here and there along the Miami River in perfection, though only in scattered patches of a few individuals. From Miami down the coast to Cocoanut Grove they appeared more or less abundantly. At Addison's Landing, near Cutler, I found myself on the Perrine grant, though Mr. Addison informed me that the plants were growing chiefly on his own section. He estimates the number of old plants at about 15,000, growing without cultivation, and states that these have descended from the comparatively few plants which were on the place twenty-five years ago, when he first occupied the land.

The original planting, he states, was done by Mr. Charles Howe, who was associated with Dr. Perrine. He has both the spined and smooth-leaved varieties, but makes the interesting statement that the latter "spreads" much faster than the former. As a matter of fact, I noticed that plants of the spined form, at this place, were exceedingly few and far between. Some fine living plants of both varieties were secured here, and these are now growing well in the conservatories of the Department. From this point I sailed southward, but found nothing of particular interest until Upper Metecombe Key was reached, where some of the most superb plants observed on the trip were seen. In one thicket, to which it was almost impossible to obtain access save at the expense of torn clothing and lacerated flesh, magnificent plants were seen where the tips of the leaves were 2 feet above a man's head.

Indian Key, where Dr. Perrine lost his life, lies just below, and beyond it is Lower Metecombe. Other keys of the group are Lignum Vitæ, Shell Key, and some lesser ones, upon all of which the true Sisal hemp plants are found in abundance. A very rough estimate of the old plants in this group of keys would be a hundred thousand, though

Fiber Investigations, U. S. Department of Agriculture, 1891.



PLANT OF AGAVE RIGIDA, VAR. SISALANA—from Nature.

in making the estimate I have relied largely upon the statements of the intelligent Bahamians living upon them. Leaving the group of keys, the agaves grow scarcer until they are found abundantly again on Key West, Boca Chica Key, and Stock Island. Other keys where they are growing are Knights, Umbrella, and Vaccus, and, on the authority of Mr. Grant, large quantities are to be found on Cape Sable, the extreme southwest point of Florida.

My survey of the west coast was not as thorough as of the east, but there is no doubt that the plants are grown in greater or less abundance from Cape Sable and Ten Thousand Islands up to Punta Gorda. Superb plants were examined by me at Fort Myers on the Caloosahatchie River and at other points, though there were no such thickets as seen on the keys.

SOIL, CLIMATE, AND CULTURE.

The frost line marks the limit of safe cultivation. This line is drawn from latitude 28° 30′, commencing on the Atlantic coast, in a southwesterly direction across the State of Florida to the Gulf coast in latitude 27° 15′.

The majority of writers state that arid, rocky land is best suited to the growth of the plant. The soil of Yucatan where the Sisal fiber of commerce is produced is described as "a gravelly, stony, and in some places of a rocky character, the plants thriving best and yielding the largest amount of fiber in comparatively arid districts only a few feet above the level of the sea." And, a moist or rich land is considered unsuited, because of the lesser yield of fiber which would result. Mr. Ranson says:

> The fact of the plant itself flourishing better may be attributed to a combination of conditions existing both in the soil and surrounding atmosphere, principal among which I notice the presence of salt, making it retentive of moisture, and of lime phosphates resultant from decaying shells. Land bordering on the Atlantic coast, which is evidently alluvion to a comparatively recent date, is generally considered too poor in the constituents necessary to plant life to make it worth while to attempt any cultivation upon it, and whilst this may be true as regards a lack of decomposed vegetable matter, yet the shelly saline sands will be found to suit such plants as the yuccas, agaves, etc., both chemically and physically, better than the rich black hummock lands.

From my own observations I do not favor those arid rocky situations "where nothing else will grow," and which are so often advocated. In fact, I should say the two extremes should be avoided. I saw on the Perrine grant Sisal plants that were growing on a stone wall, but I could not help noticing that those growing on the higher part of this wall were less thrifty and of a much lighter color than the plants on another portion where the wall was broken down. There is no doubt but that in rich garden soil very long heavy leaves would be produced, but it is a question whether the yield of fiber would be greater than in the less thrifty leaves, with the disadvantage of a greater weight of pulp and water to handle in extracting the fiber. Some tests should be made to settle this question.

In the Bahamas they do not favor this arid-land theory. In a recent report on the Bahamian fiber industry, made by James M. Rae to the governor, Sir Ambrose Shea, my own observations in Florida are confirmed. Here is the extract:

> I have both read and heard it broadly asserted that Sisal will grow and flourish anywhere, no matter how sterile or impoverished the land may be. My observations, however, do not confirm this. I do not mean to convey the idea that *really good rich land* is necessary for its successful cultivation, but merely to remove the impression,

if such there be, that the plant will thrive in dry arid sand or on rocky land void of soil. Worn-out "provision" and pine-apple fields appear to be well suited to its cultivation, while on broken rocky surfaces containing innumerable "pot holes" and crevices in which is deposited the ordinary black or red earth the plant luxuriates. Nowhere have I seen it appear more flourishing than on such lands. Certain kinds of white sandy land, found in large quantities at some islands, also suit it admirably. One of these varieties, white on the surface from being bleached by the sun, on being turned disclosed a dark-colored mixture resembling salt and black pepper, and is known locally by the term "salt and pepper land."

Another still darker-colored sandy soil is termed "mixed" land. Yet another kind, which, although white on the surface, is found to be of a reddish color an inch or two below, is very fine and close. These varieties doubtless possess some organic matter and are not to be confounded with the loose coarse sand found in scrubby plains and bay ridges, producing a natural growth of stunted palmettoes and low brush and on which nothing else will grow. Persons who have seen Sisal, cocoanuts, and guinea corn growing on the white land that fringes the eastern shore of Andros, and also on the white land of Abaco, Grand Bahama, and Harbour Island, will readily understand the description of soil to which I have reference. The Sisal plants growing opposite "The Caves," in the western part of New Providence, afford another illustration.

The soil of the Indian River region and at Jupiter differs materially from that of the Biscayne Bay region, and this somewhat from the soil of the keys. In the former there is the absence of the underlying homogeneous coral rock, resembling limestone, which prevails all along the coast of the southern peninsula. The soil of the upper region is more sandy and less compact, with the absence of lime rock. The soil in which the plants are growing on the Perrine grant resembles fine sand mixed with humus and other coarse semidecayed vegetable matter, and is dark in color, while that from Boca Chica is a rich chocolate-brown, of a more peaty nature, appearing like vegetable mold, but mixed with disintegrated lime rock. The "rock" formation (foundation) of the keys seems more recent than that of the mainland, the "coral" origin being very distinctly marked, and the soil thinner. Undoubtedly the pine barrens near the coast will give just the right conditions when cleared up and the palmetto and other scrub grubbed out. The hummock lands, of course, are richer.

The soil, commencing at Miami, and running along the entire Biscayne Bay region, according to Mr. Euan, of Miami, is a combination of shell, sand, and vegetable matter, with coral rock cropping out here and there. He states that on "marl prairie" the expense of clearing would be done away with. Cutting off the "scrub" and grubbing the average lands, with plowing, he thinks would cost $80 per acre. He suggests growing pineapples and vegetables while the Sisal is coming on. The Bahamian purchasers offered him 7 cents per dozen for young plants, which was declined. Plants grown on hummock land, fertilized by hogs and horses, he thinks will produce leaves large enough to cut for fiber in three years. The lands about Fort Myers are chiefly coral formation and disintegrated shell. It is called a sandy loam, but is in reality about 25 per cent of disintegrated shell and 8 per cent of phosphate, the remainder being sand and humus.

It is claimed that beyond clearing the land of all growth, cutting out trees, and grubbing out stumps and roots, no soil preparation is needed. With the ground clean weeds can be removed in the spring without trouble, and after the plants are well established no other weeding will be necessary.

This seems to be a very simple form of soil preparation, but clearing the land in Florida, if the work is thoroughly done, will be a considerable item of expense. Of course, where large areas are to be cleared the work would be systematized and performed under contract at half the price that it now costs the small planter.

In the vicinity of Jupiter, as I was informed, the cost of grubbing out the palmetto and other roots is $10 to $15 per acre, with $8 more for plowing. Another estimate by a practical farmer, average for the entire east coast of Florida, was stated at $50 to $80 per acre. While at Miami I saw a piece of pine barren land which was being cleared by contract for $30 an acre, though a gentleman with whom I had considerable conversation at Miami was of the opinion that for the average of land in the Biscayne Bay region it would cost $75 per acre. It must be borne in mind that these are not contract prices, and that they have been based on the experiences of ordinary farm practice, where a few acres have been cleared as wanted for general cultivation of fruit and vegetables. Dr. Washburn, in charge of the tropical subexperiment station at Fort Myers, states the cost of grubbing out the 20 cords of palmetto roots, which an acre of land produces, at $25.

Mr. Edgar M. Bacon gives the Bahamian practice as follows:

All the ground is gone over first with the machete, a long, heavy, cutlass-like knife, which the negro uses either as a tool or weapon. All trees and underbrush are cut down except the very large ones, which require an ax. Then the stumps are grubbed up, so far as they are likely to interfere with the work. Next, fire is employed, and quickly runs over the acres where the negroes have toiled in gangs with their cutlasses. In this work of clearing, women are often found more satisfactory as laborers than men, and they receive but 36 cents where the men get 50 cents. Few laborers are paid by the day. Task work, *i. e.*, so much for clearing a piece of land of a given size, called a "task of land," is the usual method. In clearing brush land in the Bahamas one-fourth of an acre is a task. When at last all the clearing and planting have been done, and thousands upon thousands of perfect plants in absolute symmetry of arrangement, with unbroken ranks, their rich green showing no blemish, stretch before the eye, the spectator (especially if he happens to have a financial interest in the plantation) feels that there is a beauty apart from mere picturesqueness.

As to the use of fire in getting rid of brush, etc., I am satisfied that unless done when the ground is wet the soil itself, at least in many localities I visited, would be burned out also and destroyed. And to put out a plantation, even in pine barren land, without clearing, would simply be to invite disaster, as the grass and palmetto are frequently burned over. Fire is particularly destructive to growths of the agaves.

There seems to be a great difference of opinion in regard to the proper distances that the plants should be set. In the Merida district of Yucatan they are set in rows 9½ feet apart and 6½ feet in the rows. According to the Bahamian Government report, made by Mr. Preston several years ago, the distance in old fields is stated at 9 feet between the rows and 4 feet in the row. Experience has shown, however, that when planted too closely the leaves are injured by being beaten together in high winds; consequently 11 by 6 and 12 by 6 was considered sufficiently close, requiring from 600 to 650 plants per acre. Mr. Cleminson, of Jupiter, Fla., advocates close planting—that is, 5 feet apart and 3 feet in the row—which would require some 2,000 plants to the acre. I think this is altogether too close.

As to the danger of injury from winds, it is claimed that Florida plantations are seldom swept by hurricanes, and that there are no other objections to closer planting. Regarding the actual practice in the Bahamas let us again turn to Mr. Rae's report, published in 1891:

The system adopted by those who have engaged largely in planting varies. Some have planted as near as 6 feet each way; others 7 by 7, 7 by 8, 7 by 9, 8 by 9, and 9 by 9. The Monroe Company, at Abaco, plant three rows 8 feet apart with 7 feet interval between the plants, and leave a space of 12 feet between every fourth row. The "Bahama Hemp Company, limited," which is under the efficient supervision of Mr. Abbott, plant four rows 8 by 8, leaving a distance of 12 feet between every fifth row. Most planters, however, have found it advisable, owing to the rocky nature of the land, not to observe too strict regularity in planting, but while adhering as

near as practicable to it, to put plants in the most favorable spots. Most of the laboring class who have engaged in planting have observed no method at all, but have put the plants in the ground wherever a good "pot hole" or chink in the rock occurs, and have planted much too thickly.

In Mexico the plantations are set out with more regularity, and in fact with the same system, as a rule, that is followed in this country in setting out an orchard. The accompanying plate illustrates the appearance of a hemp plantation on the farm of Dr. Manuel Donde, near Merida, Yucatan, which is characteristic.

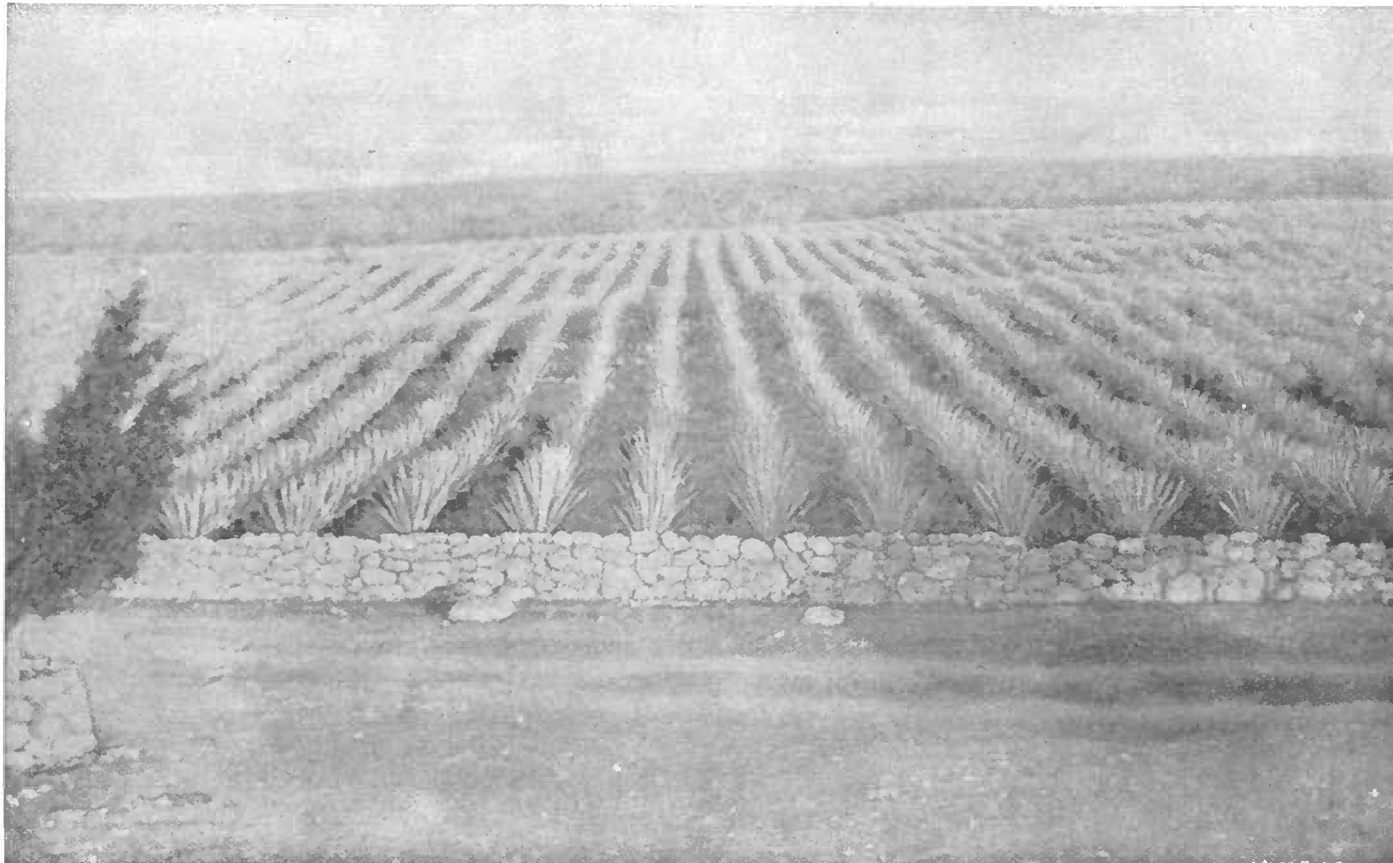
In the Bahamas many growers utilize the spaces between the rows of plants with other crops, even corn and cotton being named. The plan will work well enough provided the matter is not overdone, weeds are kept down, and the cost of keeping the land clear lessened. Sweet potatoes, however, must never be planted, as they cover soil and Sisal plants alike, to the great injury of the latter. Shade is particularly bad for growing Sisal plants. During my recent visit to Florida the bad effect of shade upon large plants was noted in several marked instances, the plants being less thrifty, and the leaves sometimes so spindling and thin as to have lost their rigid habit and to be bent and drooping.

The late Mr. Van Buren, of Jacksonville, once stated to me that "all the after-culture needed in Florida is just enough to keep down the weeds until the plants are large enough to shade the ground, say once or twice a year for the first two years; grass does not injure the plant, but it should not be shaded by undergrowth."

Dr. J. V. Harris, of Villa Franca, Fla., is of the opinion that some cultivation is necessary. That it is not needed he considers true only where the land is so very rocky that it is impossible for enough vegetation to grow to interfere with the plants; that ordinarily it is safe to calculate that it will take just as much cultivation as any other plant, and that four years will have to be spent in every instance before each crop can be harvested. In Mexico, according to an official publication, henequen plants receive two dressings the first year and one every year afterward.

Upon the subject of cultivation and care of the plantation, Mr. Edgar Bacon, writing from the Bahamas, makes the following pointed suggestions, which will apply as well in Florida as in the Bahamas:

Experienced growers use 650 plants to the acre in rows 11 feet by 6 feet distant from each other. This will give room for the laborers to walk between the rows without being wounded by the terrible spurs, which, like a cluster of keen spears, make each plant a menance to the unwary. Besides this, the closer planting would result in the piercing of innumerable leaves every time the wind blew, and the consequent destruction of much fiber. Stabs and bruises mean discoloration, and the expense of sorting damaged lots, apart from the proportional loss, would be an added and not insignificant item in the labor account of a plantation. Many people who have caught the Sisal fever are planting acre after acre, expecting nothing less than that the farms, when planted, will take care of themselves. To be successful in this enterprise requires unceasing activity and care. One must be Argus-eyed. One season of poor prices, with the consequent discouragement which is apt to follow in the case of nine small proprietors out of ten, in a country where the peasantry are all negroes, will result in an overgrowth of suckers and the poling of mature plants, till nothing short of absolute clearing and starting anew will save the farms. There is no cultivation where system and perseverance are more necessary to success. The dropping of a seed from a single "pole," if not watched and attended to immediately, will produce little spears enough to destroy a hundred plants, and I have frequently seen a dozen suckers start up around and under the leaves of their parent. After such crowding, the leaves would be worthless, even could they be reached; but no man, unless arrayed in metal armor strong and stout enough to withstand the thrust of steel, would be so foolhardy as to attempt to penetrate such a growth. What I want to impress is the fact that without that patient and systematic care which I nowhere observed as characteristic of the unled negro, a field of Sisal is as valueless as a field of mullen.



View of a Sisal Hemp Plantation in Yucatan—from Nature.

All suckers should be removed, as they are a detriment to the old plants, and when they are not needed for planting new fields they should be thrown away. In planting them out, in Yucatan, a little hole is dug and the plant introduced, after which it is propped up by a few stones and left to take care of itself. In setting out these suckers in the nursery, in Florida, they are placed 10 to 12 inches apart in rows.

The plants are reproduced in two ways, by means of the suckers which form about the bases of the mature plants, and by means of the "pole plants" which form upon the branches of the blossom-stalk or "pole" (sometimes called a "mast") after the tulip-shaped flowers have faded and fallen.

In Florida the age of maturity of a Sisal plant in the wild state is six or seven years. At this time the plant blossoms, sending up its flower stalk or pole to the height of 15 to 20 feet.

After the tulip-shaped blossoms have begun to wither there now starts forth from the point of contact with the flower stalk a bud, which develops into a tiny plant, which, when grown to the length of several inches, becomes detached and falls to the ground. Such "pole plants" as come in contact with the soil take root, and in a very short time are large enough to transplant. A single "pole" or "mast" produces from 1,000 to 2,000 plants, while only a few suckers are formed at the base of each old plant. The largest pole plants that I saw in Florida measured about 4 inches in length. But among a lot received from Mr. George Bier, from Boca Chica Key, and that had never been in soil, was one which measured 10 inches.

In regard to the flowering of the plants in the field, some writers state that the appearance of the pole should be watched for and the stalk cut out to prevent blossoming, as the plant then withers, while others state that because this indicates old age and the end of the usefulness of the plant, there is no advantage in attempting to save its life further. From the experience of Bahamian planters, not only does the cutting of the leaves retard the period of poling, but it also lessens the size and productiveness of the pole.

In Yucatan the period of usefulness lasts from six to eight years—sometimes from fifteen to twenty years—a plant fifteen years old presenting the appearance of growing at the top of a long foot-stalk, several feet from the ground. The small plants are very hardy. Some now growing in the conservatories of the Department were set out in soil for the first time in the month of November, having been received the previous March.

In making collections of young plants from wild growths of Sisal it should be noted that in many portions of the southern peninsula, and on the keys, a plant was found by me which was not Sisal hemp at all. The leaves are shorter, stouter, and less upright in habit of growth, the lower leaves especially being quite recurved and thickly armed with strong recurved spines. Very old plants of this form of agave, which I have termed "false Sisal," are observed with naked foot-stalks sometimes 2 feet or more in length. The plant differs so greatly from the Sisal hemp plant in form, color, and general characteristics that I do not see how anyone could mistake the one for the other. Nevertheless, large quantities of these false Sisal plants have been both purchased and "taken" without purchase by Bahamians, under the supposition that they were the same as *Agave sisalana*. Recently, however, Mr. William R. Smith, superintendent of the United States Botanical Gardens, has identified the plant as *Agave Mexicana*, as several of the plants are growing at the Botanical Gardens. There is also a fine plant of it growing at Mount Vernon, on the Potomac.

In Mr. Edgar Bacon's article, previously referred to, I find a statement that a gentleman in Jamaica with 500 acres prepared for hemp planting showed him the plants which he proposed to use, and which were imagined to be good Sisal plants. These were the valueless "Keratto." I am not acquainted with the plant referred to as Keratto, but in Hensley's Biologia Centrali-Americana I find *Agave keratto* given as a synonym of *A. Mexicana.*

I may state that in a large Florida nursery, containing probably 100,000 plants, which I visited, one-half, at least, were the worthless *Mexicana.*

YIELD PER ACRE.

A plant set out when 18 inches high will produce leaves fit for cutting in three years. The lower leaves, naturally, are the most mature and are cut first; these should be at least 3 feet long. Mr. Cleminson informs me that the average length of the leaf from four year-old plants, as grown in Florida, is 3 feet 3 inches when cut, and for three years afterwards 6 inches longer each year. He also states that thrifty plants at seven years will produce leaves 5 feet in length, and if the flowering stalk is cut when it first makes its appearance, the plant will continue to grow to profit for twenty-five years.

Mr. Ranson, of Titusville (the Indian River region), set out plants in 1887 that were 6 to 8 inches high. At two years the leaves of the large plants were 2 feet 8 inches long, and at three years the leaves were 3 feet 2 inches long and were fit to commence cutting. The result of one plant here of two and one-half years' growth is an average of seventeen young plants and ten leaves sufficiently long to harvest. And he states that in the fourth year such a plant will give a still larger result, increasing in usefulness each year until it flowers, in its eleventh to thirteenth year, which ends the life of the plant.

I saw plants on the west coast, said to be only four years old, the leaves of which measured over 5 feet long. I think, from the above statements, the plant must be of slower growth in the Indian River region than in more tropical Florida.

The late Mr. Van Buren stated that the product of nine hundred plants to the acre in the third year, allowing for two or three cuttings of five leaves each, equal to 12 or 15 pounds to the plant, would be 6 or 7 tons of green leaves to the acre, worth at least $3 per ton. He estimated the yield for the following year at 18 tons of leaves, from five or six cuttings, worth about $50 per acre. In the report of Mr. Preston it is stated that in Yucatan a leaf 4 feet long weighs 1.1 pounds, and measures in the widest part 3¾ inches across from spine to spine, and is one-fourth of an inch thick in the center of the leaf, 2 feet from either end. A similar leaf from the Bahamas is said to weigh 1½ pounds and to measure 4½ inches wide and five-sixteenths of an inch in thickness.

Regarding the size and weight of Florida Sisal leaves, the following table, compiled from the weights and measurements of many leaves collected during my recent trip, will prove of interest:

Fig.	Variety.	Locality.	Length of leaf.		Width of leaf.	Weight of leaf.
			Ft.	*In.*	*Inches.*	*Lbs.*
1	Smooth	Fort Myers	5	0½	4½	2
2	....do	Upper Metecombe	5	8	5	
3	Spined	Perrine Grant	4	1½	5¼	

Outline drawings, made from the freshly cut leaf, to illustrate the thickness and shape of the leaf (cross section) at base and center or widest portion, are here reproduced:

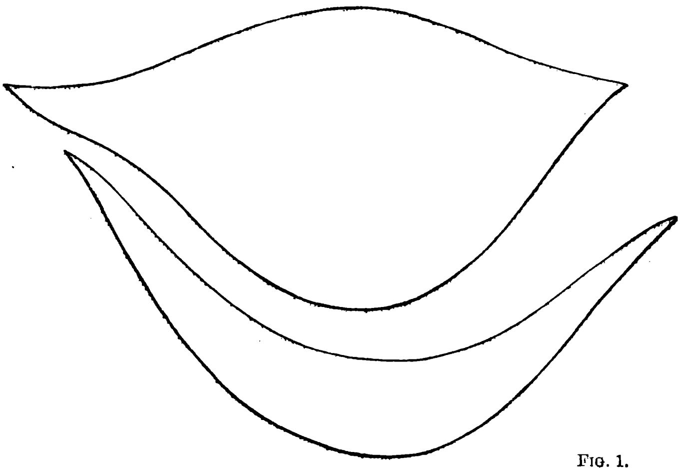


FIG. 1.

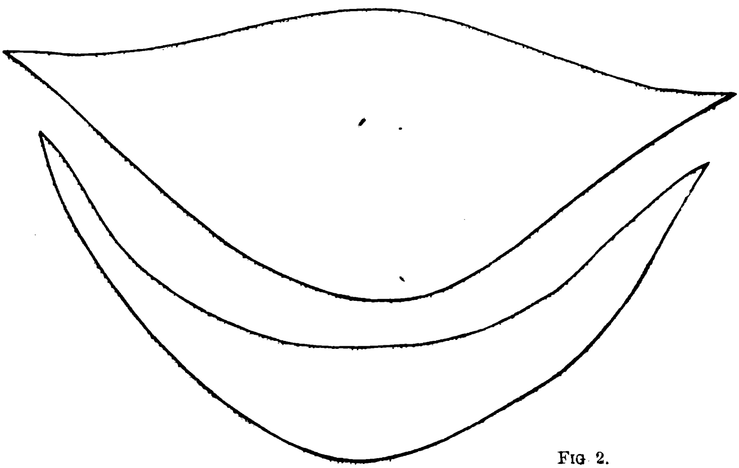


FIG 2.

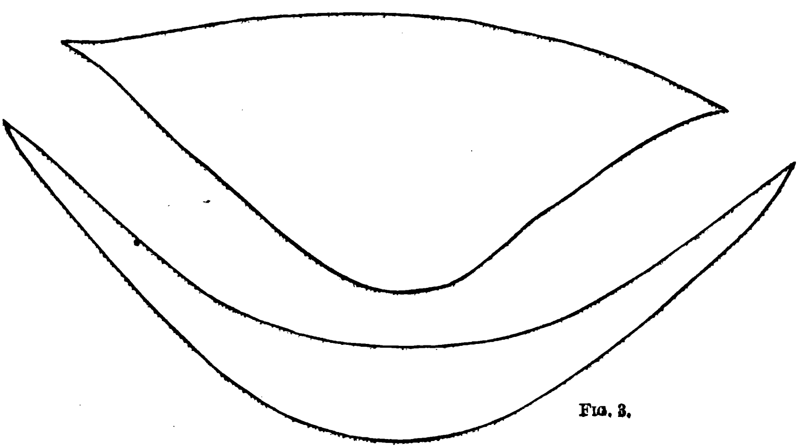


FIG. 3.

It will be noted that one of these has been made from the smooth variety of leaf. From this it may be stated that the full-grown mature leaves of Florida plants (var. *sisalana*) 5 feet in length will weigh $1\frac{3}{4}$ to 2 pounds. Attention is called to the Fort Myers example, Fig. 1, which was taken from a leaf grown in garden soil. The drawings of cross sections were made from tracings of the freshly cut leaves in the field.

Regarding yield, size of leaves, etc., in the Bahamas, Mr. Rae, in his recent report, makes the following statements:

The length of time required for the production of the first cutting of leaves may, I think, safely be regarded as four years from the time of planting. A great deal depends upon the size of the plants when transplanted, but if they be of a suitable size, say from 12 to 15 inches, without doubt the leaves will attain a length of from 4 to 5 feet and be fit to cut well within the period named. I have seen thousands of plants with leaves from 2 to 3 feet long that had been growing only two years; I have also seen plants that, I was told, were three years old, from which leaves had been already cut.

For the present the yield per acre with us can be only a matter of calculation, in consequence of the industry having been so recently begun, but sufficient positive experience has been derived to determine this point with approximate accuracy. The number of leaves cut from many plants of four years' growth and upwards has given an average of 40 leaves per tree, with an average weight of $1\frac{1}{2}$ pounds per leaf and a yield of 4 per cent of cleaned fiber. With an average of 600 plants to the acre, and 40 leaves weighing 60 pounds to each plant, the yield would be 36,000 pounds of leaf and 1,440 pounds of cleaned fiber. If the estimate be reduced to 35 leaves there will be 31,500 pounds of leaf and 1,260 pounds of fiber, and this is certainly a very modest estimate. To guard against all possible disappointment, however, the yield per acre can safely be placed at half a ton.

The Department has been unable as yet to make comparative tests in regard to the yield of fiber in Florida. A Van Buren Sisal hemp-cleaning machine was purchased in May last, and this will be taken to Florida this winter and a quantity of fiber extracted for manufacture and test. By carefully weighing leaves and fiber from several "runs" of the machine, the Florida yield may be pretty closely approximated. A quantity of leaves were shipped to Washington from Key West in June last, to be cleaned by the machine on the grounds of the Department. While the work was satisfactorily done and some superb fiber produced, from the fact that the leaves lost something in weight by their long journey, a statement of the comparative weights of leaves and the fiber cleaned from them would be misleading, so are not given here.

Mr. Bier, of Key West, finds that while the Florida fiber is somewhat finer in texture, it is longer and stronger than that grown in Yucatan, and the weight of fiber to the leaf is a fraction more in weight, the average per leaf of Yucatan being 490 grains, while ours averages 520 grains, with less moisture.

Mr. John Grant, of Jupiter, Fla., states that plants grown in Dade County, Fla., will yield 7 pounds of commercial fiber to every 100 pounds of leaves, which is equal to 140 pounds of fiber from a ton of the crude material. This approximates closely the statement made in the report of the New York Exhibition of 1853, that "75 ordinary leaves are estimated to yield $7\frac{1}{2}$ pounds of fiber." At the rate given by Mr. Grant, 75 leaves would give about 8 pounds of the cleaned product.

According to Mr. Preston's report (on the Bahamian culture), 40 leaves may be cut annually from a mature plant. At the average of $1\frac{1}{2}$ pounds to the leaf, on the basis of 650 plants to the acre, this yield gives a total of 39,000 pounds of leaves, or $19\frac{1}{2}$ tons. Mr. Preston calls it 19 tons, and at the rate of $2.50 per ton, the value of the green leaves before cleaning, we have $47.50 per acre, or almost double the value stated by Mr. Stoddard. On one of the farms visited by Mr. Preston

in Yucatan 48,000 leaves, or 72,000 pounds (36 tons), of crude material was cleaned daily. A yield of 5 per cent of fiber, which is his estimate, gives a little over 1¾ tons of fiber per acre from the 36 tons of leaves. Here is Mr. Preston's estimates, based on figures of yield in Yucatan, with cost of labor in the Bahamas:

48,000 leaves (36 tons), at $2.50 per ton	$90.00
6 wheels, each two hands, at 48 cents	5.76
3 boys supplying feeders, at 24 cents	.72
3 women to remove and hang fiber, at 30 cents	.90
Engine driver, at $2	2.00
Fuel	2.00
Incidentals	2.00
	103.38

This shows a yield of 3,600 pounds of fiber from 72,000 pounds of leaves, at a cost of $103.38, making an average of $2.87 as the cost of producing 100 pounds of fiber the product of 1 ton of leaves.

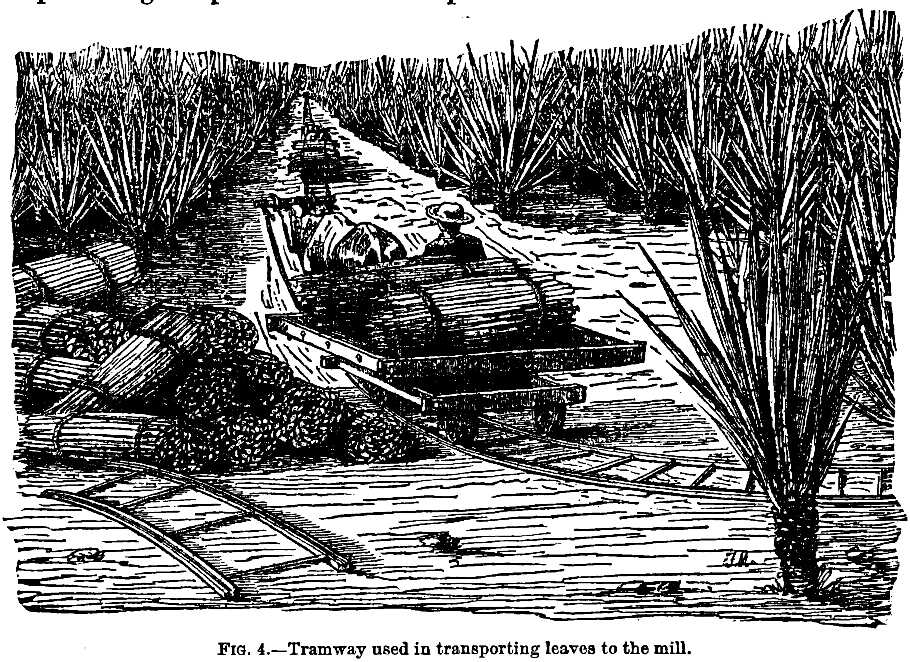


FIG. 4.—Tramway used in transporting leaves to the mill.

Mr. T. Albee Smith informs me that 1,000 leaves of henequen weigh in the rainy season 160 to 200 arrobas (25 pounds each); in the dry season 100 to 160 arrobas per 1,000 leaves. One thousand leaves average a yield of 55 pounds of fiber.

The leaves are cut close to the trunk, a sharp knife being used for the purpose. In Yucatan the spines are removed from the edges of the leaf, together with its thorn-like point, after which 50 leaves are tied together to form a bundle. About 1,500 leaves, making just a cart load, are considered a day's work.

A correspondent of the Farm Implement News, a Chicago gentleman interested in the Sisal industry, thus describes the method of harvesting in Yucatan:

This is done by the Indians, who are almost nude, with a stroke of the knife, or *machete*, at the rate of, for one hand, 2,000 to 2,500 leaves per day. Following the

Indian who cuts off the leaves is an Indian woman, who, with a knife, cuts off the spike or thorn-tipped end and the thorny side of the leaf, ready for the machine. One foreman was understood to say that it costs about 38 cents per 1,000 leaves to cut, prepare, and get the leaves to the cleaning machines. On all the large haciendas visited were little railways into the fields, upon which, on cars drawn by mules, the henequen was taken to the mill and the waste was taken away.

PREPARATION OF THE FIBER.

The cleaning of the fiber of Sisal hemp in an economical manner, after the leaves have been grown, is probably one of the chief considerations in the establishment of this industry. Prior to 1850 the question of machinery does not seem to have been thought so all-important as at the present time. In Dr. Perrine's report, of 1838, before referred to, there are drawings of two rude wooden implements which were used by the natives in extracting the fiber, as well as drawings of the leaf unscraped and scraped. Figures of the two implements are here reproduced (Figs. 5 and 6).

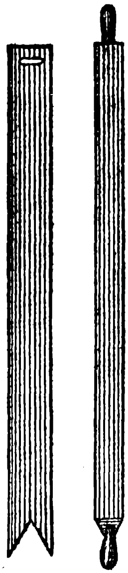


FIG. 5. FIG. 6.

The explanatory matter which accompanies the original plate gives a very good idea of the method of cleaning the leaves at this period. With the notched scraper the leaf is first slit into five or six strips. The triangular scraper is then used in the same manner that curriers do their shaving-knives.

In Squire's "Tropical Fibers," published only thirty years ago, the same laborious methods are described. Methods of fermenting the leaves in water and mud, steeping them in an alkaline pickle or confining the semi-crushed leaves in "an openwork wooden frame or box," placed in such manner that the ebb and flow of the tide should wash out the gum, are mentioned and dilated upon, with no hint of existing machinery.

Until very recently the only machine in use in Yucatan was a clumsy affair, stated to be a native invention, called a "raspador." Rude as this piece of mechanism is, it is said that a native will clean twenty leaves a minute with it, though with quite a percentage of waste of fiber. While the raspador is said to have been superseded on some plantations, it is more or less generally used at the present time for extracting the immense quantities of Sisal hemp exported. The average work of one machine is claimed to be 7,000 leaves per day with two feeders or operatives.

The following description of this machine, from a correspondent of the Syracuse Herald in Yucatan, is so concise that I give it in full:

It is simply a wheel, like a 4-foot pulley, 6-inch face, with pieces of brass an inch square and 6 inches long running across the face about a foot apart. This wheel runs in a heavy wooden case. When working well it makes about 110 revolutions a minute. The leaf is put in through a small hole in the case, and being held by a strong clamp, is allowed to whip downward as the wheel moves around. A heavy block, like the brake of a car-wheel, is, by lever, brought to bear on the leaf, pressing it against the revolving wheel. In a second the pulp is crushed and thrown into a pit under the wheel and the fiber is drawn back, one-half of the leaf being cleaned quicker than one can follow the motions. The leaf is reversed and the other end cleaned in the same manner.

It will be impossible to go into detail regarding the many machines that have been invented and patented for cleaning Sisal hemp during

the last forty years, or even to give more than a passing mention to those that have been chosen for illustration.

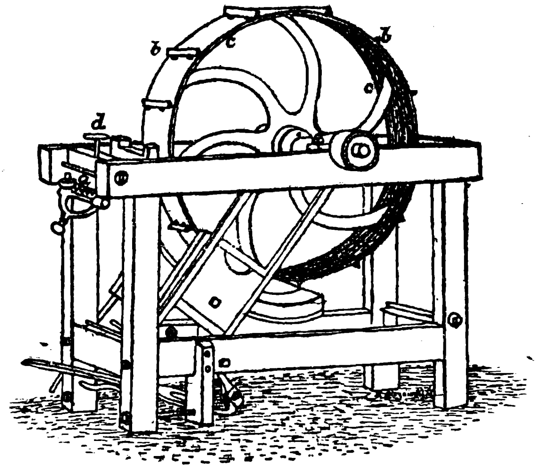


FIG. 7.—Raspador or Patruillo machine.

From a study of these machines we find that they may be referred to two types, those which take the leaf endwise (either passing it through at one operation, or reversing it when half cleaned, making two operations) or those which take a continuous feed of leaves sidewise. The raspador belongs to the first class, the capacity of which must be limited, while to the second class belong the larger and more complicated machines, among which may be named the Stevens, the Prieto, and the Villamore, of larger capacity, costing several thousand dollars, and requiring special buildings and other machinery permanently located. In short, while the machines of one class are to an extent portable, those of the other class are for the central factory or mill, and require a considerable plant and force of workmen.

The Patruillo machine was patented over thirty years ago, though there are records of earlier machines, one of these dating back to 1851, a rude device, in the main constructed of wood.

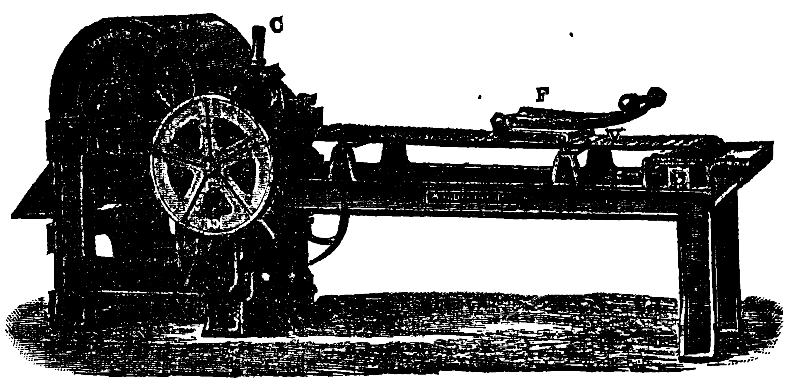


FIG. 8.—The Death cleaning machine.

In Mr. Preston's Bahamian report, mention is made that on one farm he visited six machines of the "Death" pattern were in operation,

There are two machines patented by Mr. W. E. Death, one bearing date July 13, 1885 (American patent February 16, 1888), the other July 2, 1886 (American patent June 26, 1888). In both machines water is used to assist in the cleaning of the fiber. The machine patented in 1885 is the simpler of the two. The latter machine was figured and described on page 26 of Fiber Bulletin No. 1, issued April, 1890, from information furnished by the Death Fiber Machine Company, Leadenhall street, London, last January (1890).

In a letter recently received from the Death Fiber Machine Company, London, it is stated that the old Death and Ellwood machine worked without water.* The new machine, that figured above, requires a 3-horse-power engine to drive it, at the rate of 400 revolutions per minute, and from 300 to 400 gallons of water per hour are necessary to properly clean the fiber. The machine is claimed to turn out 2 hundredweight dry fiber in ten hours.

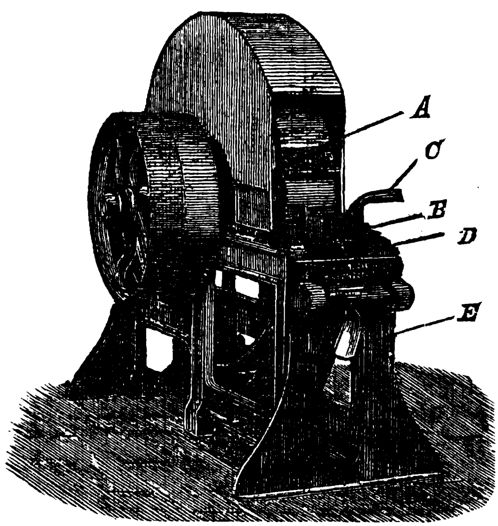


FIG. 9.—The Barraclough cleaning machine.

Fig. 9 is an illustration of a machine built by T. Barraclough & Co., Manchester, England, which is practically the raspador, as now used in Yucatan. The main points of similarity are the "raspar" or scutch wheel *A*, the block *B*, the lever *C*, for raising the block to the wheel when pressing the leaf to scrape it, the stud *D*, which is used to wrap the fiber of the cleaned end of the leaf around while the last end is being scraped, and the clamp or grip *E*, which is used to hold the leaf while the first end is being cleaned. I am informed by a mechanical engineer, who is thoroughly posted regarding the industry of Yucatan,

*We wish you particularly to note that the Death machine in use in Yucatan is the old Death and Ellwood scutcher, and very much inferior to the new W. E. Death machine. The old Death and Ellwood machine works without water, and causes a great waste of fiber; the new W. E. Death patent machine (of which we are the proprietors) works with water, which cleanses the fiber from all acids and impurities, and delivers the fiber in a pure, white, and glossy state and practically without any waste. The difference between the machine patented July 13, 1885, and that of July 2, 1886, is this: The first named is the machine and the latter is the feed motion for supplying the leaves.

that these five elements are found in all the machines used in Yucatan, of which there are almost 3,000.

I have referred to a machine invented by the late E. R. Van Buren, of Jacksonville, as having been purchased by the Department. Though a small machine, it is quite simple in construction and effective in operation, turning out remarkably clean fiber, though its capacity is limited on account of the necessity of withdrawing the half-cleaned leaf and presenting the uncleaned end, making two operations on the old raspador principle.

In operating this machine the material to be decorticated—a leaf of Sisal hemp (henequen) or any other fibrous plant of similar growth—is passed over the top of the block and is drawn in between the block and cylinder by the motion of the latter, and is macerated by the striking of the beaters; the leaf is then withdrawn, and by so doing the loosened vegetable matter is scraped off by the combs, and nothing remains but fiber contained in the leaf. This is exposed to the sun, bleached and dried, and is then ready for market. By changing the roller combs from coarse to finer ones the same machine can be adapted to a finer texture of fiber.

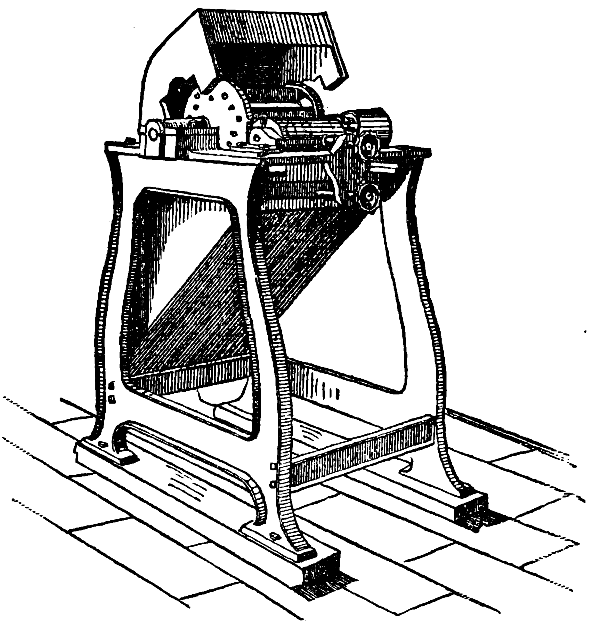


FIG. 10.—The tropical fiber machine (Van Buren).

The device (Fig. 10) is described as follows: Two disks on circular plates of iron are fitted to a shaft about 8 inches apart (this shaft passes through the center of the disks). Between them is a series of beaters, which are in pairs and are journaled into each disk and work loosely. Between each pair of beaters is a grooved roller, which serves as a comb. These parts, when put together, are mounted on a frame of wood or iron. On the same frame, and front of the machine as described above, is a wooden block, which is adjustable by means of screws either towards or from the machine. The face of this block is hollowed out

to fit the circumference of the disks. A rapid revolving motion is given to the above-described cylinder by means of a belt pulley.

In a letter received from Mr. Van Buren last fall it was stated that nothing remained to be done to perfect this machine save to add a feeding device to double its capacity. The output is claimed to be about 200 pounds of cleaned fiber in ten hours. The death of the inventor has left the machine as figured and described above.

The T. Albee Smith fiber-cleaning machine (Fig. 11) may be described as a device composed of two cleaning wheels, each armed with scrapers around their periphery, in connection with an automatic feeding attachment, by means of which a continuous line of leaves is fed sidewise to the wheels. The first wheel cleans the spine end of the leaf for two-thirds of its length. The leaf then passes through to the second wheel, the point of grip being automatically changed in order that all of the uncleaned portion may be presented to the second wheel for cleaning. The fiber when wholly cleaned is then discharged, as shown in the cut, the point of discharge being on the opposite side of the machine to that shown. The short leaves entering the machine, in the illustration, are those of the Ixtle (*Agave heterocantha*).

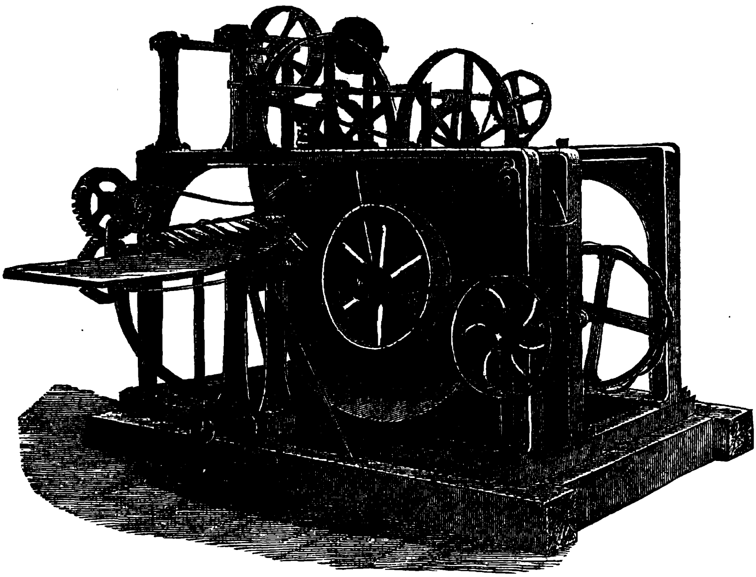


FIG. 11.—The T. Albee Smith machine.

Mr. Smith makes statements regarding the machine as follows:

Three automatic machines have been constructed—two for use in Mexico by the Mexican Machine Company, in the State of Coahuila, for cleaning ixtle, one for use in the Bahama Islands in cleaning henequen fiber. Seventy-five machines of a different design have been previously used by the Mexican Machine Company, and are now being displaced by the automatic.

The capacity of the henequen machine is 50,000 leaves per day. The services of three men are required at the machine, which weighs 6,000 pounds, and eight horse-power is required to drive it. The machine for cleaning ixtle weighs 1,500 pounds. Its capacity is 150,000 to 200,000 leaves per day, requires the services of three men at the machine, and five horse-power to drive it.

There are other machines already before the public which are claimed to work satisfactorily. Just what principles of construction are em-

bodied in them, or how far the claims have been substantiated by actual performance, the Department has not been able to learn, though the endeavor has been made to secure such information. They are therefore omitted from the present report.

THE FLAX INDUSTRY.

The trade journals, the importers, and some editors of the agricultural press, of a year ago, asserted most positively that flax could not be grown for fiber in the United States, and that the production of seed and fiber in the same plant was an impossibility. These misstatements, made partly for political effect and partly through ignorance, were challenged at the time and abundant evidence produced to prove their falsity. At the same time, the results of the present year's operations were looked forward to with the greatest interest as an experiment covering territory from Massachusetts to the Dakotas, and was entered upon by the Department of Agriculture at the beginning of the present year to demonstrate to what extent flax culture for fiber might be carried on within our borders.

Three varieties of flax were imported from as many flax countries of Europe and distributed to the agricultural experiment stations, to successful flax-growers, and to flax manufacturers, in 2 to 4 bushel lots, giving a supply sufficient for half as many acres. While the investigations are not yet completed, enough has been shown, taking into consideration the results of former experiments, to prove that, as far as mere culture is concerned, there is no doubt of our ability to grow a fine quality of flax straw in many localities—the Northwestern States, with Minnesota for the center, forming the flax-growing section at the present time.

Fifty years ago flax was grown for household manufacture in nearly every State in the Union. Only recently I have examined flax grown twenty years ago, almost in the mountains of New Hampshire, and it was good flax, too. And I am informed that in the Virginias household linen is even manufactured at the present day in small quantities. If the American farmer of forty or fifty years ago was able to make his land produce a crop of good flax, there is no reason why the farmers of to-day can not do the same thing, though not by methods of cultivation in vogue at that period. In the march of progress it was natural that the industry as conducted half a century ago should decline, and that flax-growing for fiber should naturally become a lost art.

It is too early to present a record of the season's operation in the reëstablishment of this industry, or to give the results of experiments with the seed sent out from the Department, as at this date many reports as to culture have not been sent in, and the work of reducing the straw to fiber and the final operation of manufacture are not yet completed. Good straw has been received by the Department, however, from many parts of the country, even from as far east as Connecticut. From an examination of the specimens already submitted, and in connection with the reports that accompanied them, it is shown that as far as culture is concerned there will be little trouble in growing any quantity of good flax straw. In some localities, Wisconsin particularly, dry weather is reported as having injured and in some cases destroyed the crop, though the cases were exceptional; and with earlier sowing of the seed and a different selection of soil it is more than probable that some of these failures might have been averted.

There is yet a great deal of ignorance regarding the subject, even among those who have a general interest in the culture, and who, with an assurance of money return for their labor, would go into the production of flax for fiber.

Our farmers must know the difference between poorly grown and prepared flax, which is worthless for any purpose, and the grade of flax which a little better practice will give them, and which will be salable for some purpose. This information can not be obtained by them through the medium of the published literature of the subject alone. Object lessons, in many instances, will be necessary, with opportunity to ask questions and examine and handle the well-grown product. There are two ways in which this object-teaching may be accomplished, first, by visits of experts to the farms—these being either Government special agents or the agents of State governments or of agricultural experiment stations—and, secondly, through the farmers' institutes.

During the months of July and August and part of September, Mr. Eugene Bosse, a Belgian flax-grower and scutcher of experience, a resident of the United States, was commissioned to visit flax-growing localities in the several Northwestern States and travel from one district to another to tell farmers what to do, how to do it, and where they have made mistakes in the present year's operations. I learn that Mr. Bosse's efforts were appreciated by many farmers with whom he came in contact. At the close of his labors he submitted an interesting report, extracts from which will be published later.

In studying the needs of the flax fiber industry of this country the necessity for a new practice, which shall be built up on the lines of the progressive agriculture of the present day, has already been referred to. We may consider the foreign practices merely as the foundation for a practice suited to our times and people, in which labor-saving machinery will be used in all operations, with a division of labor to the end of economy of production. Improved implements for putting the soil in the best possible condition are already found on nearly every farm in the country. Until a machine has been produced with brains and the reasoning faculty, we need not hope to see a flax weeder, nor will the American flax fields be weeded by women and children working on their knees. The weed question is not a serious one, however, save in some localities. Wild buckwheat and a species of morning glory have given considerable trouble in portions of Minnesota the present season, though other localities report little annoyance from weeds. We must pay more attention to the question of rotation, in order to learn what special crops will put the soil in best condition for flax culture and clean it of weeds. Both hemp and clover are said to be admirable weed-killers. With a more careful rotation in flax culture we shall hear less of flax proving exhausting to the soil. It must prove injurious where everything is taken from the soil and nothing returned, and with only a reliance on the natural fertility of the soil to begin with for elements of plant growth.

Our farmers must know how to properly harvest the straw when grown, and to fully understand the special operations involved in the best practice. A great deal has been said and written regarding the pulling of flax in this country, and it has often been asserted that neither the American farmer nor the foreign flax-grower farming on American soil will pull the crop in this country. Considerable flax has been pulled the present season, and while it is true that the operation is a laborious one, the fact should not be considered a discouragement,

particularly as inventive genius has already produced a flax-pulling machine which is claimed to have done good work in the field.

For the next operation—that of saving the seed, which should be worth from $10 to $15 per acre—there are several improved threshers which, while slow, with some modifications may prove practically successful; and one machine, which has been tested this season at Austin, Minn., is claimed to have done rapid work and in a satisfactory manner, though the Department has not tested the machine.

Here the farm operations should end, bringing us to the second stage of the industry, where the utmost skill and good judgment are required to make the product valuable. While good fiber can not possibly be made from poorly grown straw, without this skill and good judgment a poor fiber from a well-grown straw will be an almost inevitable result.

From a careful study of the situation, it becomes evident that something more is needed than for farmers to grow the straw. There is necessity for a class of skilled workers who shall come between the farmer and manufacturer in carrying on the operations of retting and scutching, or, in other words, the operations of soaking out the gums which hold fiber and woody matter together, and in removing this woody core or shive by mechanical means. It is futile to expect the farmer to ret and scutch his flax. It is not done on the farm in foreign countries, nor in Canada, save to a very limited extent, and it can not be done here.

As the case stands now, the farmer is hardly in position to grow flax, save in an experimental way, until he is sure of a market, and the manufacturer—that is, the spinner—is not in a position to make offers of purchase or to name a price, because he is not sure that the farmer can grow flax of the proper standard, or that he can afford to purchase at any price, for his particular manufacture, such flax as the farmer may produce.

In Canada and in northern Michigan (in the neighborhood of Yale, where there are successful flax mills) the practice is to sell the seed to the farmers, at the mills, at a fixed price per bushel, the farmers agreeing to sow a certain number of acres to flax, the straw of which the managers of the scutch mills (or tow mills) agree to take at a fixed price per ton—in some cases $10 being named.

This relieves the farmer from any other responsibility in the matter further than to produce a good crop of straw. The scutch or tow mills attend to the retting and cleaning of the fiber, which in turn is sold to the spinner. One good scutching mill will prepare the flax grown on a score or more of farms, and as the work is accomplished under one direction or head the product will be far more even as to standards than would be possible were it prepared by twenty men. The scutcher has a money interest in the matter of the production of properly grown straw by the farmer, and is in position to aid him by many hints and suggestions.

To found an American linen industry, therefore, there must be three divisions of labor, the growing of the crop by the farmer, the retting and scutching by the "factor," or purchaser of the crop, if I may so designate him, and, lastly, the spinning and weaving of the manufacturer. In the old days of household manufacture these three operations were conducted, in a small way to be sure, upon the farm.

In a recent tour of the linen fabric and flax twine mills of the country I had the opportunity of examining several samples of flax submitted the present year by farmers new to this culture. Some of these samples were made from well-grown flax, but rendered worthless for spinning purposes, save as tow, through ignorance of the proper after-prepa-

ration. At the outset of the experiment of reëstablishing this industry there will be many such costly mistakes, and I would therefore caution the would-be flax farmer to go slow. Let him put in only a few acres of flax seed (say 3 or 4 acres) for fiber, at first, regarding it wholly as an experiment. When he has gained knowledge, and the different wheels in the flax industry have been put in position, and are beginning to move, he will know something then of the demand for flax fiber, and he can extend flax culture accordingly.

The necessity of a careful study of the growth of flax for fiber can not be too strongly urged. We should satisfy ourselves as to the limits of successful culture and learn where the crop may be grown under the very best conditions to produce fine flax.

This means practically a study of the whole field of operations founded on present foreign practices. A study of soils and fertilizers is especially desirable. A strong loamy soil under a high state of cultivation has always been deemed essential to success with flax; yet I saw a field of flax in Minnesota recently, apparently in superb condition, which the owner informed me was growing in almost pure sand. A study of crop rotation is desirable—at least so far as to learn what crop or crops may be employed to put the land in the very best condition for a following crop of flax. In this connection weed-cleaning crops should be especially considered.

A study of varieties is essential, and experiments might be conducted as to the quantity of seed to be sown to the acre, ranging from 1 bushel to 2½ bushels, though this is not so important, as it is a pretty well established fact that 1½ bushels will give good seed and fiber, while 2 bushels is the proper quantity for fiber alone.

A study of the ripening of both stalk and seed is desirable to determine the precise point at which the pulling should be done to obtain the best results at the same time in both directions. I should also suggest a study of seed deterioration, with experiments to determine whether the deterioration may be retarded by special culture, fertilizers, or other agencies.

Our friends of the agricultural experiment stations in flax-growing States can aid us materially in this work, and do much toward placing this old industry upon a new and substantial foundation, and their coöperation in the good work is earnestly desired. The small beginnings made at the experiment stations the present year show encouraging results, and indicate that these institutions will be able to render valuable aid in the establishment of this industry. The work should be enlarged upon, particularly in flax-growing States, for it is only through intelligent experiment and careful practice, noting all errors and studying how to avoid them, that the system of culture best adapted to our country can be developed.

REPORT OF THE SPECIAL AGENT IN CHARGE OF THE ARTESIAN AND UNDERFLOW INVESTIGATIONS AND OF THE IRRIGATION INQUIRY.

SIR: I have the honor to present herewith a report of the operations of the office conducted by me, under your appointment and direction, for the year 1891. It covers all work done since the date of the last report made by this office, and brings to a close the Artesian and Underflow Investigation, first authorized by law on the 4th of April, 1890, extended by provision of appropriation act, September 30, in the same year, and again extended until the 1st of January, 1892, by appropriation act of March 3, 1891. Under the same section an appropriation of $10,000 was also made for the fiscal year ending June 30, 1892, for the purpose of enabling the Secretary of Agriculture to continue the collection and publication of "information as to the best methods of cultivation of the soil by means of irrigation."

Very respectfully,

RICHARD J. HINTON,
Special Agent in Charge.

Hon. J. M. RUSK,
Secretary.

FINAL WORK OF THE ARTESIAN AND UNDERFLOW INVESTIGATION.

The extension for six months of the work of the Artesian and Underflow Investigation, "within the region between the ninety-seventh degree of longitude and the foothills of the Rocky Mountains," gave great encouragement to the able men in charge of the field work and final reports ordered by Congress. The provisions of law approved September 30, 1890, required the final reports to be made and published by the 1st of July, 1891. It became evident as soon as the winter of 1890-'91 begun that such a restriction of time would almost destroy the value of all the work then done in the northern and central portions of the great field of inquiry, embracing as it does nearly one-fourth of the whole national domain, exclusive of Alaska and the Aleutian Archipelago. The time extension granted has consequently been of the greatest value, enabling as it has the field staff in both the engineering and geological divisions satisfactorily to round out and complete the work required of them by law. In order to do this properly every effort has been made, under your direction, to give to the hard-working members of both staffs all the administrative aid and encouragement possible. The nature of their work and its advanced character necessarily rendered them independent, and therefore limited the assistance of this office beyond the general plans that were formed to aid in faithfully carrying

them out. Chief Engineer Nettleton had prepared and sent from the field, under his own direction, a new artesian-well blank and other forms for statistical information. Prof. Hay, the chief geologist, confined his work in such directions to correspondence, which has been quite onerous, considering that the largest portion of his time and that of all his assistants has been occupied with field investigation.

During the early months of the year the chief engineer, with his assistant, Mr. Follett; Chief Geologist Robert Hay, with his assistant geologist for the southwest section; Prof. Robert T. Hill, of Texas, and Special Agent W. J. Gregory, of Kansas, were at work in portions of southwest Kansas, southeast Colorado, Oklahoma, the Indian Territory, and Texas, west of the ninety-seventh degree of west longitude from Greenwich; also in New Mexico, east of the Rio Grande. In March last, the weather permitting, field work was fully resumed in those sections of Kansas, Colorado, Nebraska, Wyoming, South and North Dakota, and in Montana covered by the terms of law creating the investigation. Two able geologists who served with Mr. Hay in the first inquiry, Prof. Lewis E. Hicks, of Lincoln, Nebr., and Prof. Garry E. Culver, of Vermillion, S. Dak., were reappointed assistant geologists. Mr. Hicks was assigned to Nebraska and Wyoming, and Mr. Culver to the Dakotas and eastern Montana. Mr. Hill retained the southwest until September, when he filed his report and retired from the investigation. It is proper to remark, at the close of Mr. Hill's valuable services over his field of operations, that the general investigation with also which he has been associated has been advanced by the industry and trained intelligence displayed in that field work, and by the professional ability he has shown in the important report he has made.

The chief geologist, Prof. Hay, in addition to performing the onerous work of supervision, has reported on the geological problems of the mid-plains section, that is, of western Kansas and eastern Colorado. His intimate knowledge of the geology and hydrology of this section renders it certain that his report when published by Congress will be a positive addition to both our scientific and economic knowledge. Prof. Hicks has already demonstrated his intimate knowledge of the subject of inquiry, especially within the field of observation and study he has occupied. He has largely extended in the closing report his study of the stratigraphy of Nebraska, especially of the northern section, in connection with the drainage and water-bearing capacity thereof, and the results are sure to prove of value to the people of that section, as well as to the general advancement of the study of hydrogeological phenomena and of its use in advancing settlement and cultivation. Prof. Culver's work in the Dakotas has been in completion of work previously undertaken, and is so well done that it is almost superogation to say that his final report will be of even more value and importance than the one previously published by Congress. The chief geologist briefly summarizes for this report his own and his assistants' labors.

The field work of the engineer staff has been arduous, unremitting, and most intelligent in results. The profiles and maps of the chief engineer will greatly elucidate the physical problems involved and largely enable the people of the States and Territories of the Great Plains region to comprehend the undeveloped hydrological resources that are at their command. One feature of the past year's work in South Dakota, as directed by Mr. Nettleton under the orders of the Department, has already done so much in the way of educating the farmers of that State in regard to irrigation that its value may even now be measured in prospective dollars and cents. I refer to the

policy pursued in the appointment of Mr. La Grange, of Greeley, Colo., as superintendent of irrigation experiments at Aberdeen and Huron, S. Dak. Owners of farms and artesian wells thereon at the points named gave the use of both for experimental work. They paid the cost of making ditchs, etc., for utilizing the artesian flow for irrigation purposes, and the engineers planned the works and directed their consrtuction. Mr. La Grange, a farmer of long experience in irrigation and an accomplished administrator of water interests, having served several years as water commissioner in Cache la Poudre water district, Platte division, Colorado, was placed in charge of these farms, so far as directing the use of the water was concerned. Hundreds of Dakota farmers visited both farms, and were enabled under Mr. La Grange's instruction and by reason of the object lessons afforded by the investigation to obtain practical information that otherwise would have been almost unobtainable. This work was done in reality without any cost other than that of the salaries and expenses of those who furnished plans and instruction. The chief engineer justly claims important results from the experimental work—a claim fully borne out by the correspondence of this office, proving as it does the knowledge afforded and practical encouragement given to communities otherwise greatly disheartened by insecurity and drought.

The report sent to Congress, with maps and profiles showing cross sections of the areas investigated, prepared by Edwin S. Nettleton, C. E., chief field engineer of the Department, who has been in charge of the field work of the Artesian and Underflow Investigation, will be found of great general value and live interest to all concerned in the security of agriculture on the Great Plains—nearly one-fourth of the entire area of the United States, exclusive of Nebraska. It embraces—

(1) A report of examination and surveys of the underground water in the valleys of the South Platte, Republican, Loup, and Arkansas rivers; also of a survey across the country on the one-hundredth meridian in Kansas, and of a survey across the country from Crow Creek to the North Platte River in Wyoming. This report is accompanied with tabulated data, giving detailed information concerning the wells and water plane along the lines surveyed; also by maps and profiles of the lines surveyed. This part of the final report amplifies much of the matter that was in the chief engineer's progress report of last January, which was sent to the Fifty-first Congress and published by its order. The enlargement is necessary for the fuller completement of the work performed.

(2) A report of the examination made of the drainage, springs, and subterranean waters of the Pecos River in southeastern New Mexico.

(3) A report relating to the artesian wells in the Dakotas. This contains all the information and data which the engineer staff has been able to collect up to the date of withdrawal from field work in October, 1891, embraces a discussion of the chief problems relating to such artesian wells and their sources of supply, and is accompanied by maps and profiles, by which profiles a line of wells from Yankton to Manitoba in Canada will be shown. There are also profiles of lines east and west across the artesian basin. The report embodies the result of Chief Engineer Nettleton's examination in Montana of the supposed source of the artesian supply, and also the results of gaugings of the upper Missouri River. Col. Nettleton was also authorized to supervise the irrigation experiments conducted during the summer of 1891 at points in South Dakota by the utilization of artesian water from wells. The report made of these experiments, which were under the immediate direction of Mr. La Grange, of Greeley, Colo., contains valuable data and shows that the farmers availed themselves largely of the object lessons offered. The results are in every way encouraging.

(4) A report on the shallow or drift wells in the Red River Valley in North Dakota, and of those at Miles City in east Montana, supplemented by a tabulation of detailed data in connection with these wells.

(5) The springs and underground waters along the eastern side of the Couteaux, which lies between the Missouri and James rivers, are fully reported on.

(6) A reconnoissance was made of the Turtle Mountains drainage basin in North Dakota, and a report thereon is given.

(7) St. Mary's Lake, near the British-American line, was made the subject of

examination for the purpose of determining if the waters of the same can be retained in the United States by the diversion of the St. Mary's River. A valuable report on this interesting problem forms part of the chief engineer's closing work. The chief engineer's report also contains a good deal of valuable miscellaneous information concerning subjects pertinent to the inquiry.

The chief geologist, Robert Hay, realizing that under the law extending the time of the investigation considerable work must be done during the winter months, directed Prof. Robert T. Hill to begin at once in Texas and New Mexico. Prof. Hay himself proceeded to make explorations of the water conditions of the mid-plains region of east Colorado, west Kansas, and southwest Nebraska before the severe weather set in. The assistant geologists for northern Nebraska and the Dakotas were not commissioned until early spring, in order that their time might be used during the longer days of the late spring and early summer for the field work of the more northern regions. The chief geologist employed his time and force, as already indicated, in personally making some examinations of southeast Wyoming, spent a little time with each of his assistants, and also devoted the whole of the month of July and part of August to North Dakota, and afterward made a short reconnoissance in Montana, about and below the Great Falls of the Missouri. The report of the geological field inquiry is now complete and is being rapidly put into shape for printing. It will be illustrated by valuable maps, diagrams, and photographs. Prof. Hay states that the sources of the waters of artesian wells both in Dakota and Texas are fully dealt with. It is shown that the James River Valley wells have their head far to the west, and that wells supplied from the same source may probably be expected in a considerable portion of South Dakota, between the Black Hills and the Missouri River. The wells of northeastern Dakota are shown to be unconnected with the source of the James River basin. Incidentally, it also appears that the water of very few of the wells is injurious to vegetation, and that probably some of these would lose their deleterious properties if stored in open reservoirs before using.

In Texas the Fort Worth-Waco artesian basin is carefully delineated, and the direction in which extension may be expected is pointed out by Assistant Geologist Hill. Other artesian areas in Texas are defined and the sources of their waters indicated. The source also of the series of enormous springs stretching across Texas from northeast to southwest is considered, and its relation to the rainfall of the region discussed. In the same way the structure of the plains of west Texas is shown to be substantially the same as the plains region between the Arkansas and the White River of Nebraska, and that underlying this whole region of high prairie plateau there is a supply of water sufficient to redeem a fair proportion of the land from aridity, where the rainfall is under 20 inches and where precipitation often fails at the critical period of crop growth. This water will have to be raised by artificial means, and only locally will it be found to have artesian conditions. The existence of the same water-bearing rock formation over the larger part of this great area, from the Black Hills to the Rio Grande, is conclusively shown, and its value in reclaiming a large proportion of the so-called or actual arid plains and making it serviceable to the prosperity of the country is demonstrated.

What has been called the underflow has been carefully examined. The methods of using it belong properly to the engineering part of this investigation, but whether the term is properly used outside the great river valleys has been investigated. A careful study of the exposed geology of the plains shows that the waters under the region so named are not found in any one great sheet, but are separate for each divide

of the plateau, the depressions making such breach of continuity as to restrict the underflow definitely to the valleys; at the same time by the outcrop of springs the surplus of the phreatic waters of the plateaus serves to increase the supply of the valley waters. Without further generalizing results some estimate may be made of their value by indicating here the separate topics dealt with in the reports of the several geologists.

The report of the chief geologist deals with—

(1) The structure of the Great Plains.

(2) The water supply thereof.

(3) The region of rivers having their sources therein not the mountains, with special treatment of the Smoky-Hill Republican region.

(4) The glacial formations of the plains of the eastern part of the two Dakotas and their relation to the wells.

(5) The structure that makes artesian conditions.

(6) The underflow and other topics, subordinate somewhat, but incidentally of importance.

Prof. Garry E. Culver deals specifically with the following topics:

(1) Dakota artesian basin.

(2) Natural subterranean reservoirs.

(3) Supply of water, its source and amount.

(4) The Black Hills: (*a*) Geology; (*b*) topography; (*c*) drainage; (*d*) springs and lost streams; (*e*) rainfall; (*f*) relation to the James River artesian basin.

Prof. L. G. Hicks's report has the following titles that indicate the range of his work in Nebraska:

(1) Geological structure of the State and its effect on the water supply: (*a*) The underflow; (*b*) sheet waters.

(2) Irrigable lands in the valleys of west Nebraska: (*a*) Platte valleys; (*b*) Republican; (*c*) Niobrara; (*d*) White River.

(3) Survey of the Loup River region: (*a*) Extent and surface features; (*b*) geological structure; (*c*) rainfall and drainage; (*d*) agricultural resources, irrigation, deep tillage, and forestry.

Prof. Robert T. Hill was longest in the field, and his report discusses principally the following subjects:

(1) Water conditions of the Grand Prairie regions of Texas.

(2) Water conditions of the Llano Estacado region.

(3) Underlying waters of the Red Land region of Texas and Oklahoma.

(4) Underground waters of the Pecos and Rio Grande valleys.

(5) Underground waters of the basin region, New Mexico.

(6) Water conditions of the Malpais and volcanic regions of New Mexico and southern Colorado.

(7) Water conditions of the Las Vegas plateau.

(8) Utilization of underground waters.

(9) Present uses of underground waters for irrigation: (*a*) The Pecos valley; (*b*) the Del Rio system; (*c*) the Fort Worth-Waco system; (*d*) the San Antonio system; (*e*) San Sabe and Menardville; (*f*) irrigation from windmill wells, springs, artesian wells.

Mr. J. W. Gregory, of Garden City, Kans., special agent for the mid-plains section of the great field embraced by the Artesian and Underflow Investigation, deals primarily in his report with the underwaters of the middle division (embracing western Nebraska, Kansas, and Oklahoma, and eastern Colorado), touching the existence, locality, extent, quantity, availability, source of renewal, and value of this form of water supply for use in irrigation, and the method by which it may be obtained. In the discussion of these points the modifying effects and relations of soil, climate, character of surface, precipitation, torrential waters, cultivation, and existing irrigation systems are briefly considered; also the effects of legislation, and the social, legal, and economic problems involved. His aim is to show how it may most quickly be

done and to direct attention to some of the questions which will inevitably arise.

Maj. F. F. B. Coffin, ex-State irrigation engineer of South Dakota, has served the Artesian and Underflow Investigation within the Dakotas as a special field agent. He makes a special report treating of the quartzite formation found in connection with the artesian wells, also showing that the basin itself is in the form of "a vast trough," with its great depth near or under the James River Valley, at a depth much greater than has yet been reached in the Dakotas. With these reports Mr. Coffin presents the views he holds as to the formation of the artesian basin. They will have the value attachable to those of a close observer, a careful student, and an original thinker, and will doubtless aid in developing the character of the very remarkable artesian basin which is now being exploited by the drilling of numerous flowing wells.

Mr. W. W. Follett, C. E., of Colorado, who has served as principal engineer assistant in the field and in the preparation of the report, maps, and profiles, furnished by the chief field engineer, Edwin S. Nettleton, C. E., deserves great credit for the energy untiringly shown in the prosecution of the work intrusted to him under the latter's direction.

THE IRRIGATION INQUIRY PROPER.

The action of Congress in directing by the appropriation acts of September 30, 1890, and March 3, 1891, the collection and publication of information relating to irrigation and the cultivation of the soil thereby necessitated the organization of a working plan and force to that end. From the beginning of work under the Artesian and Underflow Investigation proper, it has been the aim of the special agent in charge to obtain all the information possible, so far as it could be done without expense to that investigation itself, and incidentally to its progress. This course has met your approval. When the office of Irrigation Inquiry was organized under the first annual appropriation (1891–'92) it was already equipped with a large amount of data, in process of intelligent arrangement. The progress report already prepared under the Secretary's direction and published by the last Congress is a proof of this statement. It soon became evident that the duty imposed by the provisions of law opened a wide and important field, involving or at least touching constantly upon all the grave questions of water management, climatology, chemistry, forestry, and indeed all plant life and its relations to water, air, temperature, and soils, as well as the data involved in physical geography, geology, hydrography, and hydrology. Indeed, it involves all the elements of agronomic science. This is the larger field; one, too, of a most captivating character to the investigator and student. Bearing in mind, though, the danger of theorizing and the tendency it develops of making the data fit thereto, and realizing also the economic needs involved, the aim has been to make the inquiry one of practical utility, dealing with the facts of irrigation and its results, as far as they are yet accessible. Questions of theory are used only to guide the inquiry and to aid in making more firm and intelligent the suggestions that arise and the conclusions that are naturally reached. The effort has been to get as near as possible to engineers who plan and construct works, the operators who develop and administer systems, and the farmers and horticulturists who use the water in irrigation and cultivate their land thereby, and to learn from them directly the "how" and the cost; the methods of storage, conveyance, and distribution, with the relations between water carrier and user, and the

effects of irrigation on the soil; the bearings of climate and conditions; the advantage or otherwise to fertilization, drainage, soil, and growing crops, with the results, also, as to products, land values, methods of culture, and other economic and social effects. Having in view these general aims, the work done during the past year has been directed to the gathering of information. The small office force, of six to seven persons besides the special agent, has been steadily employed in attending to the correspondence and in arranging and collating the data obtained. Circulars have been formulated and sent out to the number of several thousand. A gratifying result is seen in the increased number of intelligent replies received, showing a large growth of public interest and individual knowledge. During a portion of March and April the special agent visited the two Dakotas, Nebraska, and Kansas, lecturing before the agricultural college at Fargo, N. Dak., and to assemblages of farmers and others at Aberdeen and Huron, in South Dakota. By invitation he also briefly addressed the two branches of the State legislature at Lincoln, Nebr., on the subject of irrigation. A great deal of information was obtained and the Department was brought into closer relation with the people interested. Early in May the special agent in charge, by your authorization, visited so much of the region west of the ninety-seventh meridian of longitude in which agriculture is affected by a greater or lesser degree of aridity as could be reached within the three months to which the journey was properly limited. This decision was reached after considering the question of appointing local agents at the present stage of inquiry, or of sending the one person whose duty it is to understand the field and to coördinate all that can be gleaned. Experience gained in the other investigation turned the decision in favor of the course adopted. The special agent, during May and June and part of July, traveled on this work over 14,000 miles by rail and more than 1,200 by other conveyance, visiting western Kansas, Colorado, Oklahoma, western Texas, New Mexico, Arizona, California, Nevada, Oregon, Idaho, and Utah. Montana and eastern Washington had been made the subject of inquiry earlier in the year by a special agent sent from this Department. A considerable area of east Montana, with Wyoming and Nebraska, was within the limits of the Artesian and Underflow Investigation. During this journey statements were obtained direct from one hundred and fifty representative men identified with irrigation systems and cultivation. Other means of data to an equal amount were also obtained. A large number of maps, plans, and profiles of construction works, photographs of irrigation scenes and appliances, and a large amount of reports and other similar matter, printed or in manuscript, were obtained for the files of the Irrigation Inquiry office. The report sent to Congress on "Irrigation and the cultivation of the soil thereby, with the physical conditions and progress for 1891," contains all this mass of information, digested, condensed, and arranged so as to be as useful as possible.

It soon became apparent to the special agent in charge that, however industriously he might work and travel, it would be impossible to examine every district or section in which irrigation is practiced. It was therefore decided to inquire into—

(*a*) Systems of works and method of distribution and ownership, such as the community ditch of the Union Colony at Greeley, Colo.; of the Mormon works and methods in southeastern Idaho and Utah; and the old Mexican system as illustrated at Santa Fé and Las Cruces, N. Mex., and in Arizona at La Tempe, and elsewhere in the Salt River Valley, for the purpose of comparing them and their results with those achieved under the larger works and plans in vogue under modern corporation systems.

(*b*) To examine new and important areas of reclamation in which inviting opportunities are presented for immigration and settlement under the inducements offered by the projection, construction, and operation on a large scale of irrigation works. Among the sections in which such methods were to be satisfactorily found are large areas in southeastern Colorado, northeastern and southeastern New Mexico, the Pecos valley in Texas, and the neighborhood also of El Paso; the Salt River and Lower Gila valleys in Arizona; considerable areas in the southern counties and in the San Joaquin and Sacramento valleys of California; portions of eastern Oregon, southwestern and southeastern Idaho; large areas in Utah, notably that under the huge Bear River works and district; the Grand River valley in western Colorado and adjacent portions of Utah, and also the southern and northwestern sections of Kansas and the western portions of Nebraska.

(*c*) The inspection of new works and of special systems of supply was one of the more important objects sought by the tour of the special agent. The San Luis Valley, Colorado, with its great canals and its 2,000 or more artesian wells, was one of the locations visited. Under his direction this inspection was made by a stenographer, Mr. Downing, who developed considerable aptitude and intelligence in the work of inquiry; while the special agent himself examined the Pecos Valley system and that of the Raton Plateau region, both being in New Mexico. The group of large canals in the Salt River Valley of Arizona was made the object of special study, as was also the remarkable examples of irrigation engineering found in operation in San Bernardino Valley and on the open areas under control of the Alessandro and Perris districts in southern California, in connection with large storage facilities now in operation or under way. The elaborate system of conveyance and distribution there found is as comprehensive as are the storage facilities. It is upon the enlargement of the latter that the future of California's semitropical horticulture largely depends. The immense canals and other works now under way in the Turlock and Modesto districts of Stanislaus County and in the Colusa and central districts of Colusa County were also carefully examined, chiefly because they will bring under cultivation extensive areas now given over to wasteful ranching or not under plow at all. Important works in Idaho, Colorado, and southwest Kansas were also examined, and for the same reason. Inquiries have also been made into plans for utilizing the phreatic and artesian waters of the arid region.

There is no doubt that a widespread and rapidly increasing interest in irrigation now exists. The reports presented to Congress through this Department offer ample illustration. This interest is not confined to the arid and semiarid region and to the citizens thereof, but it is extending all over the agricultural States. Intelligent discussion is in progress over the necessity of combined irrigation and drainage. Geologists and forestry experts are drawing attention to the need of preventing the waste of soils and farming areas produced by torrential rainfall and storm precipitation, which denudation is generally attributed to the friability of soils produced by widespread deforestation. It will be found as inquiry proceeds that available methods of flood management and torrential control can be brought into effectual use. Irrigation with drainage promises to become the necessity of farming in general, for its profitable operations are shown to be seriously affected by a neglect of the same. So much has been done in southern Louisiana and in Florida in the way of irrigation for sugar cane, orange orchards, and vegetables, chiefly by means of artesian wells in both States and by distributing stream water by means of pumps and flumes in Louisiana, that it has been deemed proper to present the facts, so far as known, in a special paper.

In addition to these matters, the annual report will contain a valuable paper, with plans and illustrations, prepared specially for the Irrigation Inquiry by C. E. Grunsky, C. E., of San Francisco, on "Methods of irrigation in the San Joaquin Valley." Mr. Grunsky was formerly assistant engineer in the State engineer's office, and has a full, practical, and professional knowledge of his subject. The special agent is also indebted to Mr. Grunsky for other important data which have been utilized in the report to Congress.

SPECIAL WELL INQUIRY.

Mr. Howard Miller, PH. D., has served the Department and Office of Irrigation Inquiry as a special agent, without remuneration, in a line of investigation which promises to be of great value to the people of the transmissouri and mid-plains section, and of importance to physicists in determining the phenomena of phreatic or underground waters. The field which Mr. Miller has in charge embraces the Kansas division of the Union Pacific Railway, west from Wa Keeney in Kansas to Magnolia in Colorado, and is concerned with observations of selected wells along that line, twelve in number, and owned by the railroad, by which the rate of rise and fall of water in them is systematically recorded on forms arranged in this office, with the aid of such simple instruments as self-acting floats and upright gauges. These latter were devised by the engineer and draftsman of this office. The Weather Service Office has also provided thermometers and rain gauges for the use of the observers who are connected with the several stations and employed by the railroad. Mr. Miller first suggested these observations in March, 1891, and the first well selected was that at Weskan, Kans., close to the border of Colorado. In submitting the proposition to this Department, Mr. Miller offered the use of said well and the service of the railroad employé stationed there. He also stated that he was authorized to tender any other aid that would assist in determining whether or not the mid-plains section can be permanently made fit, by the finding, storage, and distribution of phreatic or underground waters, for agriculture by the improved methods of irrigation, and, as a result thereof, for the maintenance in security of a considerable population. The offers thus tendered, involving as they did no obligations or conditions other than those of close observation and the recording of the same, which was accomplished at a very trifling outlay, were accepted, and Mr. Miller was appointed and placed in charge. The value of this course was increased by the fact that the small field staff of the Artesian and Underflow Investigation was actively employed elsewhere within the region, and also because it would enable this office to procure systematic data extending over a much longer period than that of the regional investigation named. Observations were begun at Weskan, and they still continue. In August last, by Mr. Miller's advice, the number of wells was increased. The returns from the Weskan well show a certain daily rate of rise and fall of water therein, but that would not of necessity establish a correlation with other wells, or in any way other than by conjecture indicate that such rise and fall could be coördinated with the drainage conditions of a large area. Twelve wells were then selected from the entire line, between Wa Keeney and Magnolia, a distance of 309 miles. The following table gives their location and other items of importance:

List of wells.	Elevation above sea level.	List of wells.	Elevation above sea level.
	Feet.		*Feet.*
Magnolia, Colo	5,318	Weskan, Kans	....
Byers, Colo	5,188	Lisbon, Kans	3,079
Agate, Colo	5,443	Monument, Kans	3,107
Lake, Colo	....	Oakley, Kans	2,981
Hugo, Colo	5,027	Buffalo Park, Kans	2,695
Kit Carson, Colo	4,273	Wa Keeney, Kans	2,391

A period of several months will be necessary to decide in some degree upon the synchronous character of this phreatic supply and to deter-

mine, through the tabulated observations, the conditions of quantity and those of possible utilizations. The whole matter is one of great importance, and Mr. Miller's intelligent interest and supervision deserves, as it receives, earnest commendation. The table thus given is taken from the progress report he has made, as are also the following suggestions, which Mr. Miller terms "established facts." He says:

Every Union Pacific Railway station between Kansas City and Denver can be pumped dry.

The elevation does not have much to do with access to water, showing that the water-bearing strata are not of uniform deposition. This is confirmed positively by the observations and other work of Chief Engineer Nettleton and his assistant, Mr. Follett, over the same region.

A fairly uniform depth may be expected for wells on the same general plateau. Failure to find water is rare; no engineering difficulties present themselves, that is, none which are insurmountable. The difference in elevation between the eastern and western well-test is 2,927 feet. The average fall from east to west is 9.5 feet per mile for the distance covered.

In places, penetration of the fresh-water strata results in securing salt water. The water found is generally good; where it is not, inorganic matter is found in solution.

GROWTH OF IRRIGATION.

The growth of irrigation and the reclamation of arid lands thereby is proceeding with as much rapidity as population, prudence, and business interests warrant. A table forming part of the map which accompanies this report illustrates the growth under review. The Department of Agriculture has been first in this field of observation, as in all others relating to the interests of those who till the soil. Its publications from 1864 down to date illustrate this continued inquiry. The work begun definitely, however, in 1885–'86, when a first report on "Irrigation in the United States" was prepared by the Department. From that report the amount of land "under cultivation" west of the one hundredth meridian of longitude can be estimated at less than 4,000,000 acres. The acreage "under ditch" was estimated at 8,000,000. By this term is signified acreage that can be reclaimed through irrigation by and through works already constructed or very nearly completed. At the date of the first report the principal portion of the acreage actually cultivated by irrigation for crops, other than grass, was found in southern California, Colorado, New Mexico, and Utah, and embraced at least eight-tenths of the whole area so served. Of the area "under ditch," the four States and Territories named contained three-fifths. The rapid growth of occupation and settlement under the impulse given and interest aroused by that report (the publication of which was the immediate cause of the appropriation of $100,000 for an irrigation survey under the direction of another department) can be seen by the following figures. It must be stated here that these are largely estimates, though very carefully gathered, analyzed, and compiled. It is believed that they are under rather than over the facts:

Totals.	Acreage.					
	Under ditch.			Under cultivation.		
	1889.	1890.	1891.	1889.	1890.	1891.
West of the 97th meridian of longitude west from Greenwich	12,765,304	16,367,794	*Estimated.* 18,286,207	5,000,000	7,577,600	*Estimated.* 8,001,526

The growth in five years, that is, from the close of 1866, when the first report was finally completed, up to the close of 1891, when the one now in the printer's hands was finished and filed with the Secretary, is certainly satisfactory. The increase in cultivation is over 3,000,000 acres, and that "under ditch" is not less than 10,500,000. The most notable fact is that of the change in the character of cultivation itself. There is, of course, in the more than 8,000,000 acres reported as "under cultivation," a considerable area, especially in Montana, Nevada, and Wyoming, that is flooded simply for meadow or cattle feeding purposes. But there has been a steadily increasing proportion of the whole area laid in crops, other than grass or forage. The increase of such cultivation can not be less than 40 per cent in 1891 over that of the production of 1888-'89. The difference will be not less than 50 per cent over that for 1885-'86.

The diffusion of cultivation is another evidence of reclamation interest. The report of 1885-'86 showed very little interest in Idaho, Montana, western Kansas, and Texas; none at all in Nebraska, or the Dakotas, eastern Oregon, and Washington; no irrigation growth in northern or central California and only a comparatively small area in Arizona. In 1891 the figures of cultivated land and of areas under means of reclamation by irrigation show a remarkable degree of progress in all directions.

Another noteworthy sign of progress is seen in the steady increase of the area of fruit culture, which though very small in comparison with the greatness of the arid region itself, is very large when compared with previous years. Over the whole area, but especially in Arizona, California, Colorado, and portions of Idaho, Montana, and eastern Washington, there has been a very steady progress. The total of growth can not be less in area than 200 per cent in the older irrigated communities, while elsewhere it is entirely new and virgin. The area planted to fruit is very large, and taking the entire region it will stand in the ratio of 10 acres to 1 in bearing trees, vines, and bushes. The increase in the use of wells and other phreatic waters is very helpful in this important direction. The total number of artesian wells in operation west of the ninety-seventh degree is stated at 13,695. At 20 acres each, these wells will irrigate 273,900 acres. There are at least 20,000 more dug or bored wells, used mainly for domestic and stock purposes, but their use in irrigation, chiefly for gardens and orchards, is on the increase. It may fairly be estimated, from data gathered by this office, that these sources of water supply now irrigate 100,000 acres and that the total irrigation practiced from underground supply will serve at least 1,500,000 acres.

OFFICE AND MAP WORK.

The field work has been accompanied by the accumulation in the office of much material for use. Under my direction the office engineer and draftsman has been engaged in gathering material for an elaborate monograph on irrigation machinery, tools, wells, pumps, windmills, and other methods, appliances, and materials. It is designed to present therein, with illustrations, a concise, clear, and intelligent account of such important matters. Its details will assist the irrigator in utilizing economically and practically the supplies that may be commanded. Among works under way are the keeping of records of irrigation enterprises, of new water supplies and their utilization; of wells

and their relations to farming; of the discovery and existence of phreatic or underground water sources and service; of new storage basins; of land values under irrigation, and as to the products that are raised by such system of cultivation. Considerable translation is being done in the office for the purpose of obtaining the most authoritative data from the French and other European agronomists and engineers engaged in irrigation, agriculture, and their hydraulic work.

The map which accompanies this report and the one sent by the Secretary to Congress primarily serve as an object lesson to illustrate the extent of the reclamation of our arid lands. The statistics of this subject are not yet in a condition to give details with such an exactness as is desired, but these may soon be attained. Still, the areas and locations which illustrate the progress of reclamation by means of irrigation are, as a rule, more than approximately correct. This map will also, incidentally, indicate the American and historic modes of land settlement, as well as the progress of reclamation. It is not quite so regular in movement as the theorists demand, and, in the order of its going, it certainly has not stood upon the dicta of those who declare in advance of facts the impossibility of irrigation unless their own ideas and conceptions of the relations of hydrography and topography are followed and obeyed. Whoever seeks to understand the costly processes of commonwealth building will find in it ample aid to study. It serves to show the need of first consulting the human agencies embodied in settlement, occupation, and cultivation. Experience is with the American the chief teacher, and this he will always obtain for himself. The work of the Office of Irrigation Inquiry is based on a clear apprehension of this almost axiomatic statement. It aims to deal with economic facts, and not with mere projections or guesses, however scientific in aim or scholastic in form. It seeks, however, to follow the luminous evidence that true scientific research throws over the path of every sincere inquirer. To that end, in the reports forwarded to Congress from this Department, the effort has been made to correlate lucidly the facts learned and the observations presented, with physical and natural phenomena and their governing laws, so far as the same are known and accepted.

In conclusion, allow me to repeat what was said in the Report for 1890, that is, that considering the limitation imposed, the means employed, and the time engaged, no more practical investigations have been carried on at less outlay and none brings with them a promise of larger results to all interested, than those of which, under your direction, I have had the honor to be in charge from the first. The work of this inquiry, I repeat, is fitly intrusted to the Department of Agriculture, which from time to time since its organization has given prominence to irrigation questions, and especially so when in 1885 it authorized the writer, under the direction of the Statistician, to prepare the first report on "Irrigation in the United States," which was afterward published by order of the United States Senate. This work was the foundation of the present inquiry.

UNITED STATES

DEPARTMENT OF AGRICULTURE

OFFICE OF IRRIGATION INQUIRY.

Map illustrating the Progress of Irrigation within the Arid and Semi-Arid Region of the United States west of the 97th degree of longitude west from Greenwich.

Prepared by FRANK BLAISDELL, Civil Engineer.

1891.

NOTE.—Irrigated area represented by portion colored in blue.

Irrigation Areas and Artesian Wells West of the 97th Meridian.

State and Territory.	Acreage. Under Ditch. 1889.	Under Ditch. 1890	Under Ditch. 1891. Estimated.	Cultivation. 1890.	Cultivation. 1891. Estimated.	Number Artesian Wells. Estimated.
Arizona	529,200	643,450	660,000	310,100	315,000	a 45
California	3,294,000	4,044,000	4,500,000	3,444,000	3,550,000	3,500
Colorado	2,813,273	4,082,738	4,200,000	1,585,000	1,757,162	4,500
Idaho	715,500	1,181,500	1,200,000	327,000	330,000	12
Kansas, west of 97° of longitude	500,000	860,010	900,000	100,000	120,000	250
Montana	986,000	1,100,000	1,250,000	400,000	410,000	36
Nebraska, west of 97° of longitude	50,000	65,000	200,000	10,000	40,000	100
Nevada	142,000	150,000	150,000	75,000	75,000	76
New Mexico	638455	677,315	700,000	450,000	465,000	10
North Dakota	.	1,000	2,500	1,500	2,000	b 670
Oregon, east of Cascades	75,000	100,000	125,000	45,000	45,000	6
South Dakota	100,000	100,000	100,000	22,000	54,000	b 950
Texas, west of 97° of longitude	200,000	340,000	350 000	160,000	160,000	c 1,000
Utah	700,000	700,000	735226	413,000	423,364	d 2,524
Washington, east of Cascades	75,000	150,000	175,000	60.000	75,000	10
Wyoming	1,946,876	e 2,172,781	e 3,038,481	e 175,000	e 180,000	6
Total	12,765,304	16,367,794	18,286,207	7,577,600	8,001,526	13,695

NOTE.—This map and table are necessarily estimates, made by the Irrigation Inquiry, but both are well within the facts. All the wells given come within the definition of "positive" artesian water adopted by this office.

(a) The first successful artesian well in Arizona was drilled in 1881; the total given was reached by 1888.

(b) The deep artesian wells in Dakota, now completed, number 105; the shallow flowing or drift wells are estimated at less than 800. The State engineer reports over 100 township wells contracted for and in process of construction, and about 250 more private enterprises are reported. In North Dakota there are 19 deep flowing wells, and about 650 flowing shallow wells in drift deposits in the Red River Basin.

(c) In Texas, in 1890, about 700 flowing wells, deep and shallow, were reported upon, and at least 300 more have since been bored.

(d) The Utah total is the statement of the U. S. Census, accepted as correct in the Territory, up to July 1, 1890. The number has since been increased sufficiently to warrant the estimate of 2,800. These are all shallow depth, flowing wells, supplied from drift deposits. This is an addition of 276 wells, making the total 13,971.—Statement of Territorial experts.

(e) From report of State Engineer Mead, 1889–'90, and of Mr. P. L. Naismith, assistant engineer, for 1891, made to this office. The figures given for 1891, as "under ditch," are from the State records; those for 1892 include 856,700 acres as covered by works in process of construction or projection under prior appropriations.

OFFICE OF IRRIGATION INQUIRY,
December 31, 1891.

Richard J. Hinton
Special Agent in Charge.

REPORT OF THE CHIEF OF THE SEED DIVISION.

SIR: I have the honor to submit herewith the report of the Seed Division for the fiscal year ending June 30, 1891. There is great similarity in the operations of this division from year to year in receiving, putting up, and sending out seeds; so much so, that it seems almost a repetition of the same old story, and yet there are differences in the varieties of seeds purchased and the force employed in putting them up ready for distribution. During the past year a greater number of packages of seeds have been sent out than in any preceding year, and yet the distribution was completed some four weeks earlier than in 1890.

This is truly gratifying, as the husbandman should have the seed he intends to plant by the time he starts the plow, so that there may be no time lost, for frequently a delay of a day or two in the time of planting makes a difference of a week or ten days in the maturing of the crop. In regard to the germinating qualities of these seeds, we have carried our tests as far as our facilities would permit, and no seeds have been sent out which would not grow.

We have not only tested the seeds in the usual way, but when the test was not fully satisfactory we have given a second, and, in one or two instances, a third test in the soil, at the proper temperature; and if the proper percentage was not then reached, the seeds were returned to the party from whom they were purchased. The most of the reports received from the recipients of seeds are truly flattering, but once in a while some one fails in his or her expectations, not because the seeds were inferior, but because the seed bed was not properly prepared, or the manner or time of planting, or the condition of the soil, or weather was not favorable. We desire specific reports from all, but many are worthless because the varieties are not specified. The Japanese buckwheat and White Wonder oats have given universal satisfaction. The 3 tons of imported flaxseed sent out in the spring produced a good fiber and a large yield of seed. The tendency among the best farmers of the country is to raise fewer of the cereals and more grass, especially where markets are distant. Experiments are going on all over the country in order to find the best grasses for each locality. Alfalfa, crimson clover, Kentucky blue-grass, and Japan clover, with some others, are well spoken of by farmers generally.

I regret to have to say that in proportion to the number of packages sent out and the number of persons supplied with seed from this division the reports of results, because of a failure to name varieties, are comparatively worthless for the purpose for which I conceive them to be intended, namely, to serve as a basis of practical and sound conclusions as to the adaptation of various plants and varieties of plants to particular sections of the country. A special effort has been made in sending out packets this year to emphasize the obligation incurred by the recipient in the

matter of furnishing reports as to results, and to give him such instructions as will facilitate his doing so. It is hoped that this effort will meet with some degree of success.

As the Seed Division continues to grow from year to year, we become more and more hampered for room in which to receive, put up, and handle all the seeds necessary to supply a majority of the demands made on the division, and we hope Congress will come to our aid with a liberal appropriation for a new building which will meet our wants and facilitate the work of the division.

The only change of any consequence in the personnel of the force was the appointment of Mr. James S. Stocking as superintendent of the seed room in place of Mr. Henry A. Myers, resigned. I am happy to state that the new superintendent has taken hold of the onerous duties devolving upon him in such a manner as to afford gratifying assurance of his efficiency and the wisdom of your appointment.

Of the other persons permanently employed in this division I have only terms of commendation to offer.

Respectfully submitted,

J. B. PECK,
Chief.

Hon. J. M. RUSK,
Secretary.

CONDENSED REPORTS FROM CORRESPONDENTS.

ALABAMA.

Vegetables.—The Morning Star and the Horsford's Market garden peas were early and productive. Dewing's Blood turnip beets and the Sugar pumpkins produced fine vegetables, which grew very large. The Moss Curled Endive was exceedingly fine; it grew large and was well flavored.

ARIZONA.

Corn.—The Minnesota King grew 6 feet in height, every stalk bearing from two to four ears, with eight or ten rows on the cob; it was an early variety.

Oats.—Hargett's White grew to the height of 4 and 6 feet, and produced full, plump grains.

Vegetables.—The Dwarf Improved Okra was all that could be desired.

ARKANSAS.

Buckwheat.—The Japanese made a fine yield, and when disseminated more thoroughly among the small farms in this section will undoubtedly prove a blessing to the State.

Corn.—The Piasa King is an excellent variety; it forms a good-sized deep grain with ears averaging 11 inches in length with 14 and 16 rows of grain. It yields at the rate of 60 bushels to the acre. The Hickory King can not be excelled for earliness and smallness of cob.

Cotton.—King's Prolific is both prolific and early; the bolls ripen and open ten days or two weeks earlier than other varieties tested. The Southern Hope made a very good yield; the staple was very fine, and appears to be well adapted to this section. One pound of the Peerless seed sown yielded 300 pounds of seed cotton; the quality of the lint was very fine.

Teosinte.—This forage plant grew vigorously from the first and reached the height of 10 or 12 feet, with six to ten stalks to the hill; all stock eat it with avidity; it is an excellent forage plant.

Wheat.—Currell's Prolific made an exceptionally large yield.

Vegetables.—The Hollow Crown parsnips grew large and were of fine flavor. The Yorkshire Hero peas were very satisfactory, and the Stratagem is also reported as a fine variety. The Mammoth Chile squash grows very large and is finely flavored.

One specimen weighed 70 pounds. Pike's Peak or Sibley squash is also a favorite. The Telegraph tomato produced fruit of good size, fine in color and flavor. The China Stump root radish and the Black Mexican sweet corn are among some of the Department seeds which are highly commended.

CALIFORNIA.

Corn.—The White Giant Normandy germinated well and grew in such a remarkable way as to attract the attention and admiration of the neighborhood; the test was sufficient to prove that it surpasses anything of the kind that has been grown here.

Oats.—Every kernel of the White Wonder germinated, sending up a great number of vigorous stalks that grew to the height of 6 feet, the straw being strong and crowned with large heads of heavy grain. From the ascertained amount upon a rod, the yield to the acre was found to be in excess of 200 bushels; the weight of a bushel was over 40 pounds. A sheaf was sent to the local fair held at Sierra and received the first premium; it was the wonder of the cereal department. The White Bonanza also bore fine large grains and was very prolific.

Tobacco.—The Havana did well, and was pronounced by experts to approximate very nearly to the imported Havana. The Broad Leaf Havana was also very successful.

Vegetables.—The Everbearing peas made an astonishing crop; they began bearing very early, grew to the height of 4 feet, and continued to blossom and bear until frozen, in October; the pods were large and well filled and the flavor was very fine. The Early Blood turnip beets (without irrigation) grew to a great size and were finely flavored. The Early Summer cabbage was a great success.

COLORADO.

Corn.—The Piasa King was planted at the same time and under the same circumstances as several other varieties; it averaged 6 feet in height and bore two large, well-filled ears to the stalk; the stalks were large and heavy, while none of the other varieties attained more than 3 feet in height, producing no ears. It yielded at the rate of 40 bushels to the acre. The Minnesota King did very well, and matured good grain without irrigation; it is undoubtedly the corn for this soil and climate.

Oats.—The Bonanza grew thriftily; the straw was large and rank; it was from 2½ to 3 feet in height, with long heads, well filled with large, plump, heavy grains despite the hot, dry weather; it is highly recommended as a valuable acquisition. One quart of the White Wonder sown produced 122 pounds of fine oats.

Wheat.—The Hard Red Fyfe proved to be of unusual vitality, and yielded about 38 bushels to the acre.

Vegetables.—The Pomeranian White Globe turnips were very large and a very superior variety. The Crosby Early sweet corn proved to be an early and good variety. The American Wonder peas were very prolific. The Acme tomatoes were the best of half a dozen kinds tested. The French Breakfast radish was very quick in growth and excellent in quality.

CONNECTICUT.

Tobacco.—The Havana grew well, and when cured was of fine flavor.

Vegetables.—The Dwarf German wax beans made a large yield of well-flavored beans. The Early Red onions were very prolific. The Extra Early American Wonder peas were very satisfactory.

DELAWARE.

Tobacco.—The Havana is reported as having made a large leaf, of good quality, suitable as a wrapper. It is a good bearer and a remarkably hardy plant.

Vegetables.—The Lima beans, king of the garden, are reported as very hardy vigorous growers; they will bear planting as soon as the ground will allow, and therefore are early to mature and produce a greater amount to the stalk than other kinds tried.

FLORIDA.

Vegetables.—The Red-Seeded Citron melon produced well. The Chartier and All-Cream lettuce both did well. The White Egg turnips grew to perfection, some of them weighing 3¾ pounds each. The Early Rachel beans are considered a great acquisition; they are very prolific, very rich and tender. The Netted Gem muskmelon was small, but exceedingly well flavored.

GEORGIA.

Cotton.—One quart of seed of the Truitt produced 500 pounds of seed cotton; this variety succeeds well here, and it generally has five locks to the boll and spreads well when given sufficient room. The Southern Hope proved to be of fine quality and well adapted to this soil and climate.

Wheat.—One-half gallon of seed of the New Genesee yielded 1 bushel of fine, plump grain without fertilizers.

Vegetables.—The White Strasburg radish proved to be exceedingly fine. The Silver Skin onions gave perfect satisfaction. The Early Drumhead cabbage, the Hybrid sweet corn, and the Golden Wax beans are especially commended.

IDAHO.

Vegetables.—The Premium Gem peas were very flourishing and made a fine crop. The Dark Red Egyptian beets were very successful. The White Top Strap Leaf turnips made very sound vegetables of large size. The Crook Neck squash matured early and were very sweet; they weighed from 2 to 4 pounds. The Bassano beets were early and of good size.

ILLINOIS.

Buckwheat.—The Japanese was very early and a fine variety; it was a week earlier than other kinds tested, and very productive.

Oats.—The White Wonder had large straw and made very superior grain. Two pounds of seed sown harvested 55 pounds of very choice oats, weighing 40 pounds to the bushel. One head that was counted contained 111 grains. Hargett's White was very satisfactory; other varieties sown on either side of it were entire failures.

Wheat.—Four pounds of the seed of Currell's Prolific harvested 3 bushels of good wheat. The Rudy (bearded) came up well, stooled out satisfactorily, and yielded long heads, the estimated yield being 45 bushels to the acre. The Fulcaster is well adapted to this soil and climate; it went through the winter successfully, while many other varieties were failures. The wheat was very fine. The New Genesee did moderately well; the straw was strong and reached a good height; it is a good grower when planted early; it contained 2 kernels abreast in the head and yielded 32 bushels to the acre with only ordinary cultivation.

Vegetables.—The Yellow Belgian carrots made an excellent growth and were excellent in quality. The Quaker Pie pumpkin, the White Egg turnip, and the White Cabbage lettuce all did exceedingly well. The Yellow Globe onions bore abundantly; they were very mild and of good flavor. The Stratagem peas were very prolific; the vines grew very high, the pods having nine or ten large peas. The Fulton Market tomatoes bore excellent fruit; a single vine trained on a trellis bore 50 large-sized tomatoes. They were sent to the city as a curiosity.

INDIANA.

Oats.—A correspondent writes, in July, that the White Bonanza was promising to do finely, much better than other varieties planted. It is reported as weighing 40 pounds to the bushel, after much injury from unfavorable weather. Still another correspondent reports the White Wonder as growing straw from 6 to 8 inches taller, and that each head examined had from 20 to 40 grains more than several varieties sown side by side; it is thought that it will yield $1\frac{1}{4}$ bushels more per acre than other varieties.

Tobacco.—The Gooch is considered the best of five varieties grown for chewing tobacco and for manufacturing grades; it is somewhat darker than others, but the leaf is long, bright, and heavy; it matures well. The Henderson Pryor has a broad bright leaf, but is a little lighter in weight. The Yellow Oronoko and the Yellow Pryor matured well.

Wheat.—The Velvet Chaff was five or six days earlier than several other varieties; the heads were large and well filled; the straw was short and free from rust, and it is reported as "harvesting as good wheat as was ever grown in Adams County." The New Genesee grew vigorously and produced good clean wheat. Four pounds of the Improved Rice produced 80 pounds of good wheat. A correspondent from Posey County writes: "In 1889 I received from the Department 1 quart of Rudy and harvested from it 44 pounds; in 1890 seeded three-fourths of an acre with the 44 pounds and thrashed from that amount 36 bushels and 6 pounds. This year (1891) have 22 acres sown with it. It is a bearded wheat with a large berry, and winter-kills less than any other variety I have ever tried in this latitude."

Vegetables.—The Chartier lettuce remains tender and fit for use a long time. The Champion of England pease proved to be excellent; they bore a long time; the pods were well filled and the pease were of fine flavor. The Cheese pumpkin is excellent for table use. The Dark Red Egyptian beets did well.

INDIAN TERRITORY.

Cotton.—The Champion Cluster was of excellent quality, and if the season had not been so unfavorable the yield would no doubt have been very large.

Wheat.—The New Mexican Mediterranean did well and yielded at the rate of 24 bushels to the acre, although sown very late.

Vegetables.—The Livingston Beauty tomatoes are a favorite variety. The American Wonder peas were very good. The American Large Flat Dutch cabbage was very satisfactory.

IOWA.

Buckwheat.—The Japanese made a large yield; the 2 quarts of seed produced 50 pounds of plump grain.

Oats.—The White Bonanza is considered a valuable acquisition; 2 quarts of seed sown yielded 70 pounds of good grain. The White Wonder was very satisfactory in both quality and quantity.

Wheat.—The Velvet Chaff stands the winter well, and 4 pounds of seed sown yielded 70 pounds of excellent wheat. One quart of the Rudy produced 70 pounds of A No. 1 grain. One quart of Currell's Prolific yielded 60 pounds of equally good wheat.

Vegetables.—The New Peach tomato made an excellent crop; the fruit was of good quality and good flavor; it was a fine bearer. The Black Mexican sweet corn did finely; every seed appeared to grow. The American Large Flat Dutch cabbage made very fine heads; 100 plants set out yielded 100 solid heads. The Smooth Tours pumpkin was very prolific. The Saint Valery carrots were very satisfactory.

KANSAS.

Buckwheat.—The Japanese grew well and produced abundantly.

Corn.—The Eclipse proved to be an excellent variety. The Hickory King did well; it matured in ninety days; it was of good quality and made a good crop.

Forage.—The White Wonder beans were No. 1 in quality and are well adapted to this locality.

Oats.—The White Bonanza was sown two months too late, but notwithstanding matured and yielded good grain; it is thought, under more favorable circumstances, it will prove a great acquisition. The White Wonder was considered a success; the stalks grew large, with long broad leaves, and some of the heads contained from 75 to 100 kernels each.

Wheat.—Currell's Prolific yielded at the rate of 28 bushels to the acre, notwithstanding great injury from the Hessian fly. The New Genesee yielded 38 pounds from 2½ pounds sown; it is, without doubt, a superior wheat for this section. The Red Fyfe grew finely and yielded 20 bushels from 1 bushel sown. The Improved Rice made a very good yield. One quart sown thrashed out 1¼ bushels of grain.

Vegetables.—Dexter's Extra Early peas were ready for market two weeks earlier than other varieties; they were very productive and of good flavor. The Jumbo watermelon was a very fine bearer. The Jersey Wakefield cabbage made large heads; every plant set out headed well. The Livingston Perfection tomato is all that its name implies as regards earliness, quantity, and quality.

KENTUCKY.

Tobacco.—The White Burley is well adapted to this soil and climate; it cures up bright, and makes a fine yield and a good body.

Wheat.—The Fulcaster germinated well and made a good long bearded head, which was well filled with large plump grain. The New Genesee made a fine growth; it was of good height and stood up well; the berry was fine, of good size, and very bright. Four pounds of seed of Currell's Prolific yielded 30 pounds of good grain.

Vegetables.—The Black Mexican sweet corn is one of the finest for this soil and climate yet introduced here. The Champion of England peas should be called the "Champion of the World;" they began blooming when 2 feet high and continued blooming and bearing until they reached 6 feet, thus affording an abundant supply of delicate green pease of immense size. The Dark Red Egyptian beets were very early and excellent in size and flavor.

LOUISIANA.

Corn.—The Piasa King did remarkably well and made a very heavy yield.

Cotton.—The Southern Hope promised to be superior to other cottons raised in western Louisiana, and stood the drought much better than other varieties planted.

Clover.—The Japan proved very successful and grew luxuriantly until frost, and made fine pasturage.

Vegetables.—The Miller Cream muskmelon produced an abundance of fruit; it was small, but highly flavored. The Hanson lettuce was excellent and tender. The Florida Favorite watermelon was very prolific, of good size and of fine flavor. A correspondent writes: "All the vegetables sent by the Department here gave entire satisfaction."

MAINE.

Buckwheat.—The Japanese was a decided success; a trifle less than 6 quarts sown harvested 15 bushels; stock thrive on it, and this variety has proved very superior for feeding stock or for family use.

Oats.—The Improved American and Hargett's White were both healthy in growth and free from rust; they made a good yield and the grain was of good weight. The White Wonder was a week earlier than the common oats sown here; the yield was much larger and the weight nearly 10 pounds more to the bushel. Farmers in this section will make no mistake in sowing it. The White Bonanza harvested 94 pounds from 1 pound sown.

Forage.—The White Wonder beans made a bountiful crop.

Vegetables.—Perry's Hybrid sweet corn proved to be an excellent variety; the stalks grew 7 feet high; the ears were fine and large; it was medium early and very prolific. The Purple Top Strap Leaf turnips were a success. The Acme tomatoes made a heavy yield of large handsome fruit. The American Wonder peas, the Mammoth Hubbard squash, the Extra Early red onion, and Dewing's Improved Early turnip beets are all reported as being very successful.

MARYLAND.

Oats.—The White Wonder gave very satisfactory results.

Tobacco.—The Oronoko made a fine crop; the Gooch also proved very satisfactory.

Wheat.—The New Genesee, after many drawbacks, produced a light growth of straw with long heads well filled with grain. The Velvet Chaff was a strong thrifty grower and stood the winter well.

Vegetables.—The Giant Pera cucumbers were prolific, large, and elegant fruit. The Red-Seeded Citron melons were prolific and most satisfactory. The Sugar pumpkins are a valuable addition to the stock of winter vegetables. The White Olive-shaped radish was of good size and quality.

MASSACHUSETTS.

Vegetables.—The Eugenie pea was of medium size, but very rich and tender. The Bismarck beans were of quick growth, very sweet, and proved to be all that was claimed for them. The Siberian kale made a hardy plant, with curled leaves that were fine, tender, and of delicate flavor. The Cheese pumpkins were of very fine grain and rich in flavor; they were round, with a bright yellow skin; some of them weighed 18 pounds. The Morning Star peas were very early and good in quality.

MICHIGAN.

Buckwheat.—The Japanese was a great success; the berry was large, making excellent flour; 1 pound sown yielded 620 pounds of the very best grain.

Oats.—Many reports from this State speak in unqualified terms of the White Wonder; it grows about 4 feet high, with heads a foot long. One pound of seed yielded 40 pounds of excellent oats, which took the first premium at the Bancroft Fair. The Bonanza grew rapidly and ripened early, making a good yield; the kernels were large and very heavy.

Wheat.—The Fulcaster is a good strong grower and very hardy; the berry is plump, large, and of fine quality; the yield was excellent. Currell's Prolific yielded well and the grain was of good quality. The New Genesee had stiff straw and yielded well. The Rudy (red-bearded) had long heavy straw, stood the winter well, and bore a large berry.

Vegetables.—The Sugar or New England pumpkins are unsurpassed in quality. The Dexter Extra Early peas were early, sweet, and productive; too much can not be said in their favor. The Boston Marrow squash was very prolific, the fruit of good size and quality. The Sweet Spanish peppers were very productive.

MINNESOTA.

Corn.—The King of the Earliest proved to be two weeks earlier than other kinds. Its growth was strong and vigorous from the start. It is considered a valuable variety for this section of the State.

Wheat.—The Velvet Chaff was highly satisfactory; it thrives well in this climate; the straw is long and the kernels plump. Five pounds of the Hard Red Fyfe sown yielded 70 pounds of clean wheat.

Vegetables.—The White Globe onions grew well; their average weight was nearly a pound each. The Early Richmond and Gen. Grant tomatoes gave great satisfaction. The White Strap Leaf turnips yielded at the rate of 400 bushels to the acre. The Early Blood turnip beets grew to a good size and were of a rich red color. The Early Flat Dutch cabbage made fine solid heads. The Early Jersey Wakefield cabbage was pronounced to be unexcelled.

MISSISSIPPI.

Corn.—The Piasa King did well; it yielded at the rate of 32 bushels an acre; it was a week earlier than other varieties.

Cotton.—The Ellsworth is well adapted to this soil and climate; the lint was long and fine. The Peterkin is considered one of the best and most productive varieties that has been introduced into this section for a number of years, combining as it does all the points that go to make up a really good cotton, *i. e.*, long lint, small seed, a robust plant, very prolific, with good-sized bolls, and withal moderately early; it is simply "good enough."

Tobacco.—The Sumatra is an A No. 1 variety, and is thought to be a great acquisition.

Vegetables.—The Blue Peter peas bore luxuriantly. The Valentine beans began bearing before reaching their full height, and yielded countless clusters of fully ripe peas. The Egyptian Globe beets bore well. Boyden's Wonder eggplant was a great success. The Red Japan squash, the Tamhonnock lettuce, the Kidney Wax beans, and the King of the Garden Lima beans were all very satisfactory.

MISSOURI.

Cotton.—The Jones Improved matured well; 3 quarts of seed planted yielded 450 pounds of seed cotton; it made a third more than other kinds planted under the same circumstances.

Oats.—The White Wonder bore very fine grain and was very prolific. The White Bonanza grew finely, producing large heads, which were very heavy.

Tobacco.—The Little Sterling is an excellent variety; it grew thick, large, and strong. The Hester was also very satisfactory.

Wheat.—The Velvet Chaff grew to a good height and made strong straw. A correspondent writes: "It was the finest in quality, the largest grained, and the heaviest wheat I have ever seen." The New Genesee made a fine growth of nice, bright, stiff straw, and shelled out 34 pounds from the 1 quart of seed sown. The Golden Pacific did remarkably well, yielding at the rate of 30 bushels to the acre.

Vegetables.—The Asylum sweet corn made very fine large ears. The Russian turnip radishes were crisp and tender. The Improved Dwarf Okra is well worthy of cultivation. The White Bermuda onions were nice and tender. The Trophy tomatoes produced compact clusters of fruit in immense quantities. The fruit was large, smooth, of a bright color, very solid, and of excellent flavor. The All Cream lettuce was fine, large, and tender. The Golden Summer squash made a heavy crop of beautiful fruit.

MONTANA.

Vegetables.—The Early Cory corn has proved to be one of the best, earliest, and most prolific varieties that has been grown in this State, and for early market can not be surpassed. The Cardinal tomatoes were very prolific, very palatable, and without a blemish. The Round, Thick-leaved spinach produced finely; the quantity is surprising, and for "greens" is unsurpassed.

NEBRASKA.

Corn.—The Minnesota King has done finely and is considered the best for this section, taking into consideration the elevation and the northern latitude.

Oats.—The White Wonder did especially well and proved to be an excellent variety. Hargett's White is admirably adapted to this climate.

Wheat.—The Red Fyfe met just the needs of this section of Nebraska. The Fulcaster yielded about 18½ bushels per acre; the conditions of culture were not wholly favorable.

Vegetables.—The Perfection Curled spinach, the Danvers Half Long carrot, and the White Bermuda onions, were all very successful. The New Peach tomatoes

germinated well and were fine in flavor. The Stone Mason cabbage headed well. The Dark Red Egyptian beets were large and fine. Stowell's Evergreen sweet corn was very sweet and tender.

NEW HAMPSHIRE.

Vegetables.—The Edmunds Improved Blood turnip beets proved to be very good. The El Paso or Mexican onion was nicely flavored; it was a pretty white onion, very delicate in appearance. Dexter's Extra Early peas were true to name. The American Large Flat Dutch cabbage made large solid heads.

NEW JERSEY.

Oats.—The White Wonder was highly satisfactory.

Vegetables.—The Golden Dwarf celery did finely; the stalks measured 37 inches in length and 13 inches around the butt; every seed germinated. From one seed of the Trophy tomato were raised two tomatoes weighing, respectively, 16 and 21 ounces. The Washington Market Lima beans were an exceedingly fine kind. The Pee & Kay corn was very early and of good quality. The Long Standing spinach was true to its name.

NEW YORK.

Buckwheat—The Japanese proved to be superior to any other variety grown here. It made a larger yield on the same kind of soil, maturing several days earlier, and making whiter flour.

Oats.—The White Bonanza was highly satisfactory, making beautiful grain.

Wheat.—Forty quarts of the Rudy (bearded) were sown on three-fourths of an acre. It was not a favorable season, but the wheat came out in the spring and flourished finely, and yielded when thrashed 390 quarts of good wheat. The New Genesee yielded eleven times the amount of seed sown, and the grain was very plump.

Vegetables.—The Golden Marrow squash deserves especial mention as a strong grower; the fruit was superior in quality and it was insect-proof. The Green-Curled Scotch kale grew finely. The Yellow Belgian carrots were very delicate and the roots were of extraordinary length. The Emerald Gem parsley grew very luxuriantly and was beautiful in color. The French Breakfast radishes were sweet and tender. The new Hybrid sweet corn is highly praised by all who have tried it.

NORTH CAROLINA.

Cotton.—The Peterkin grew several inches taller and broader than other varieties grown here. It fruited well.

Vegetables.—The Buttercup lettuce and the Six Weeks beans were both very satisfactory. The Netted Gem muskmelon is small, but highly flavored. It yields abundantly. Stowell's Evergreen corn has made phenomenal crops in this section. The Siberian kale grew well and made beautiful plants. The White Bush squash produced abundantly.

NORTH DAKOTA.

Wheat.—The Red Fyfe was very satisfactory. It made larger heads and plumper grain than other varieties on the same soil. A farmer writes that from an experience of ten years he is fully convinced that the Red Fyfe made a better yield, ripened earlier, and was better adapted to this locality (Red River Valley) than any of the kinds before tested,

Vegetables.—The Early Rachel beans are considered a hardy variety. The Danvers Half Long carrots grew to a larger size and were excellent in quality. Both the Early Jersey Wakefield and the Large Flat Dutch cabbage headed well and were large. The White Bermuda onions were the best of several varieties tested.

OHIO.

Buckwheat.—The Japanese produced more largely than other varieties planted. It yielded at the rate of 23 bushels per acre.

Clover.—The Alfalfa and Alsike both made very strong growth and stood the drought well.

Forage.—The Kaffir corn was a very strong and thrifty grower and made a large crop. The White Wonder beans were a wonder indeed. They are remarkably productive.

Grass.—The Red Top did exceedingly well.

Oats.—The Bonanza yielded well and was of good quality. It took the second premium at the Holmes County Fair.

Tobacco.—The Hyco made a vigorous growth, reaching to the height of 5 feet; the leaf was exceedingly fine. The White Burley is generally considered the most profitable variety in this locality; it ripens earlier, has a brighter color, and is heavier in weight than other varieties.

Wheat.—The Improved Rice did very finely and has a long good berry. The New Genesee yielded 132 pounds from 3 pounds sown. The rate per acre was 44 bushels and the weight 63 pounds to the bushel. The Rudy (bearded) thrashed 70 pounds of nice plump grain from 2 quarts of seed sown. The same quantity of Currell's Prolific produced 50 pounds of small but very nice grain.

Vegetables.—The Giant Pera cucumber is pronounced by some correspondents to be the best grown. The Boston Market celery is a good standard variety, of excellent flavor. The Carmine turnip radish was sweet and tender. The Yellow Strasburg onions were excellent. Lane's Imperial beets were excellent in flavor and made a large yield of good-sized fruit. The Cuban watermelons can not be excelled.

OKLAHOMA.

Corn.—The Hickory King made a very fine yield. It proved true to description.

Wheat.—The new Genesee stooled from 20 to 30 straws to the bunch and thrashed out 4 bushels of fine wheat. The straw grew over 4 feet high and the heads were from 4 to 6 inches in length.

Vegetables.—The Red Cherry tomatoes were very early. They were good bearers and of fine quality. The Nutmug muskmelons were prolific bearers, very juicy, and well flavored. The Perfection Curled lettuce was very satisfactory. The Refugee beans were very tender, bore a long time, and are admirably suited to this climate.

OREGON.

Grass.—The Italian Rye has done better than other varieties on the dry hill land and is considered better for several reasons: (1) It is hardy when young, and grows thriftily the first year; (2) it was green until August, when it made seed and dried up, but started again in September and grew well; (3) it is a good nutritious pasture grass and does well where timothy fails.

Oats.—One and one-half pounds of seed of the White Wonder yielded over 6 bushels of good grain. It is well adapted to this soil and climate. The White Bonanza grew well, with extremely large heads filled with fine plump oats, the weight being 40 pounds to the measured bushel. The Welcome was a decided success. It filled well and was free from rust.

Wheat.—The Naples was a very thrifty grower, the leaves being very large and somewhat resembling rye; it stood the winter well; the straw was tender and did not stand up well; it grew to the height of 3½ feet; the grains were larger than the seed planted; it is considered a desirable variety for Oregon; it ripened about the same time as other grain grown there, but it only made a moderate yield. The Hybrid Dattle grew small but tall straw, with red chaff heads of fair length; it stood the winter well and made and kept a good stand; it stools well. Some bundles when bound were 12 feet in length; the yield was only moderate, although the grain was heavy. It is not regarded as profitable to raise here, although it is better than the Naples.

Vegetables.—The Ignotum tomato did well; the fruit was of medium size; it was smooth and of good flavor. The Surprise muskmelons were a great success, the flesh rich and thick. The Black-seeded Simpson lettuce, the Early Horn carrot, the Mexican corn, and the Cheese pumpkins were all highly prized. The Egyptian beets were "perfect beauties."

PENNSYLVANIA.

Buckwheat.—The Japanese proved to be excellent both in quality and quantity; it yielded double the amount of any other of the varieties tested.

Oats.—The White Wonder grew vigorously; it was 8 inches taller than other kinds in the same field, and was entirely free from rust; 1 quart sown yielded 7 bushels of grain; the weight per bushel was 36 pounds and the yield per acre 56 bushels, being double that of other varieties in the same locality.

Wheat.—The yield of the New Genesee is said to have been in excess of other varieties sown in the same soil; it has proved a good, strong grower, with short plump heads; the straw is bright in color and very stiff; it has a white medium-bearded head.

Vegetables.—The Extra Long Green Turkey cucumbers were exceedingly fine and productive; superior to other varieties raised here. The Red Top Strap Leaf turnips gave wonderful results. The Early Winningstadt cabbage is well adapted to

this climate. The St. Louis Market lettuce is without a superior; it grows large, is very tender, and of fine appearance. The Everbearing peas are all that can be desired. The Yellow Belgian carrots did well.

RHODE ISLAND.

Vegetables.—The Flat Dutch cabbage made fine heads of excellent quality. The Acme tomatoes made good-sized fruit of fine flavor. The Early French Scarlet turnip radishes grew quickly, were smooth, crisp, and of excellent flavor. The Boston Pickling cucumbers yielded abundantly.

SOUTH CAROLINA.

Cotton.—The Sea Island Hybrid yielded at the rate of 1,408 pounds of seed cotton to the acre; the lint was extra in length and very elastic. The Southern Hope made a good crop; its staple was extra fine; its culture will doubtless be very profitable.

Wheat.—Three pounds of the seed of Currell's Prolific sown yielded 3 bushels and 3 pounds of grain; 1 grain produced 25 heads, the heads averaging 62 grains, some of them reaching as high as 82 grains.

Vegetables.—The Flat Dutch cabbage and the Salamander lettuce both gave satisfactory results. The Large Drumhead cabbage made good solid heads. The Improved Yellow cantaloupe made a very prolific yield. Westerfield's Chicago Pickling cucumbers proved to be a desirable variety.

SOUTH DAKOTA.

Oats.—The White Wonder yielded well, the berry was very nice, plump, and short; the straw stood up well and grew to the height of 5 feet; there was no appearance of rust. Two bushels of seed sown yielded 64 bushels of good oats, which took the first premium at the Hutchinson County Fair.

Vegetables.—Henderson's New York lettuce made a vigorous growth and was of good quality. Edmunds' turnip beets and the White Egg turnips are both highly recommended by those who have cultivated them. The Danvers Yellow Globe onions were highly satisfactory. The Bassano beets and the Early Wakefield cabbage both did well.

TENNESSEE.

Cotton.—The Southern Hope was of excellent quality; the staple was very fine and long.

Clover.—The Alsike gave perfect satisfaction.

Wheat.—The Rudy (bearded) did very well.

Vegetables.—The Dwarf German kale was a success in every particular; the growth was rapid, while the foliage preserved its tenderness and crispness until late in the season. The Netted Gem muskmelon distanced all competitors in productiveness and flavor. The Improved Long Green cucumbers were a brilliant success; they bore in abundance to the end of the vines, and seemed rather to relish the dry weather than otherwise.

TEXAS.

Corn.—The Piasa King is spoken of very highly; 3 pints of seed planted in drills yielded 12 bushels of good sound corn. The Hickory King made a very fine crop; it has a very small cob, with large white grains, and is considered a very superior variety. The Angel of Midnight and the Pride of the North both yielded well, and both matured two weeks earlier than other corn planted at the same time.

Cotton.—The Ellsworth, Shines' Prolific, and the Truitt varieties all proved very good; the first two mentioned were given the preference. One quart of the Southern Hope was sown on one-tenth of an acre; it yielded 610 stalks, of which 600 matured fruit, from which was picked 125 pounds of seed cotton. It was pronounced by cotton-buyers the finest staple ever exhibited in this market.

Clover.—The Alfalfa did well until dry weather set in; while all the native grass dried up the Alfalfa seemingly stood still, waited for moisture, and when rain did come, in September, did very well.

Oats.—The White Bonanza was very satisfactory; the heads were nearly all well filled with fine white kernels, and the straw grew strong and high.

Tobacco.—The first planting of the White Burley was very good; the second planting grew 5 feet high and stood the dry weather better than any other kind tested; it is a desirable variety.

Vegetables.—The Stratagem peas were very early and large; they were very prolific and of delicious flavor. The Long Green cucumbers were brittle, juicy, and of excellent flavor. The Early Bush Scallop squash grew thriftily and yielded heavily. The Netted Gem muskmelons were very satisfactory. The Bismarck Butter Wax beans germinated well and bore abundantly. The Bastian beets and the Rosy Gem radish both did well.

UTAH.

Oats.—Two quarts of seed of the Improved American yielded 4 bushels of good grain; the kernels were well filled. The straw was very fine and grew about 4 feet high.

Vegetables.—The Edmunds beets were early and of good quality. The Philadelphia Butter lettuce was excellent. The Yorkshire Hero peas were exceedingly fine, the flavor was excellent, and the yield enormous. The Six Weeks beans were true to name.

VIRGINIA.

Wheat.—The New Genesee stools well and stands up moderately; the straw was nice and bright; it yielded 20 bushels of good grain to the acre. The Rudy is a superior wheat, bearing very large grains.

Vegetables.—The Extra Early Advance, the Large Round and the New Peach tomatoes were all excellent in quality and very satisfactory as to quantity. The Surehead cabbage was a prolific bearer and made fine solid heads. The Yorkshire Hero peas produced a profusion of pods filled with large, sweet peas. The Improved White Spine cucumbers surpassed expectations.

WEST VIRGINIA.

Buckwheat.—The Japanese is decidedly the best ever sown in this section; it was an unfavorable season, and other varieties sown by its side were not worth the cutting.

Corn.—The Piasa King is highly recommended; many of the stalks grew over 12 feet high, a large proportion of them bearing two large ears.

Clover.—The Alsike makes a fine stand and is considered very desirable for bees and for pasture.

Oats.—The White Wonder was highly satisfactory; it grew to the height of 4 feet 3 inches and yielded abundantly of fine grain.

Tobacco.—The Connecticut Seed Leaf and the Long Leaf Gooch are both reported as having done well and being well suited to the soil and climate; they are as early as the Burley and of finer texture. The White Burley did very well.

Wheat.—The Rudy yielded 30 bushels to 1 bushel sown; it was very satisfactory. Currell's Prolific yielded about 40 bushels to 1 bushel sown, and was excellent in quality. The Improved Rice yielded about the same, and both varieties stood up well.

Vegetables.—The Southport Red Globe, the Red Wethersfield, and the Yellow Globe were all good varieties of onions. The Early Curled lettuce was very satisfactory. The Dark Red Egyptian beets grew very large. The Bloomsdale spinach continues crisp long before seeding.

WISCONSIN.

Buckwheat.—The Japanese yielded 40 bushels per acre; it has been cultivated here for several years and has never made a failure.

Oats.—One-half pound of the White Wonder sown yielded 60 pounds of good grain.

Wheat.—One pound of the Red Fyfe produced 26 pounds of good wheat.

Vegetables.—The American Large Flat Dutch cabbage made large compact heads. The Osage muskmelons were very satisfactory. Moore's Concord sweet corn is a good variety. The Philadelphia Butter lettuce produced large tender heads. The New Short Stem Drumhead cabbage has short stems, and produced large heads of fine quality.

WYOMING.

Buckwheat.—The Japanese made a fine crop.

Corn.—The Pride of the North and the Minnesota King both did well.

Tobacco.—The Oronoko and the Hester both did well, and it is believed to be the first tobacco raised in northeast Wyoming.

Wheat.—Two and three-fourths of a pound of seed of the Red Fyfe yielded 200 pounds of good wheat.

Vegetables.—The Large White Belgian carrots were very prolific. The Gen. Grant tomato made a fine crop of excellent fruit. The Stone Mason cabbage was very early, hardy, and produced large, firm heads. The Early Cory sweet corn is reported by a farmer as being the only variety of sweet corn he has ever made a success in ripening in this locality.

Statement showing the kinds and quantities of seed issued from the Seed Division of the Department of Agriculture, under the general appropriation act of Congress, from July 1, 1890, to June 30, 1891.

Description of seeds.	Varieties.	Senators, Representatives, and Delegates in Congress.	County statistical correspondents.	State statistical agents.	Agricultural associations, experiment stations, and miscellaneous applicants.	Total.
		Packages.	*Packages.*	*Packages.*	*Packages.*	*Packages.*
Vegetable	206	3,686,262	191,600	46,170	1,134,615	5,058,647
Flower	128	367,764	46,140	11,635	206,527	632,066
Honey plant	2				251	251
Herbs	12				160	160
Sunflower	1				1,028	1,028
Tobacco	11	55,386			4,238	59,624
Tree	2				1,334	1,334
FIELD.						
Wheat	4	1,024	3,470		3,625	8,119
Oats	2	12,487	316	138	2,693	15,634
Corn	6	7,652	9,432	2,022	1,663	20,769
Buckwheat	1	598	2,592		2,559	5,749
Sorghum	3	236	138		498	872
Kaffir corn	1				2,239	2,239
Turnip	8	3,028	111,248	17,580	33,488	165,344
Mangel-wurzel	1	131	342	206	1,837	2,516
Grass	10	13,761	684	318	5,358	20,121
Clover	4	345	292		2,146	2,783
Millet	1	79	261	129	1,012	1,481
Teosinte	1				432	432
TEXTILE.						
Cotton	5	9,178	143		839	10,160
Flax	3				4,256	4,256
Ramie	1				28	28
Grand total		4,157,931	366,658	78,198	1,410,826	6,013,613

REPORT OF SUPERINTENDENT OF GARDENS AND GROUNDS.

SIR: I have the honor to submit the following report for the year 1891, together with some papers on general horticultural subjects, and on planting shade trees in cities.

WILLIAM SAUNDERS,
Superintendent.

HON. J. M. RUSK,
Secretary.

GARDENS AND GROUNDS.

The labor required in the ordinary care and keeping of the 40 acres embraced in the grounds, the arboretum, lawns, roads and walks, and outside propagating plats, the conservatories, greenhouses, fruit, and propagating houses absorb a large portion of the appropriation allowed for this division. During the summer all the sheds used for storing sashes, tools of all kinds, lumber, coal, etc., have been completely renewed; they were rough-boarded, unsightly, leaky structures, and have been replaced by neat buildings, weather-boarded and painted. The exotic grapery, a house of 150 feet in length by 26 feet in width, has been entirely renovated by removing all the glass, repairing the woodwork where required, reglazed, afterwards receiving three coats of paint, and is now as good as when built over twenty years ago. Much work of this kind has been expended on others of the glass structures, which should be continued until the whole of them have been overhauled and repaired.

The distribution of plants has been unusually heavy, also involving much time and labor. The labor expended upon this item required the employment of four workmen, expert at the business from long experience, for a period of over four months during winter and early spring, and, in addition to this, material for packing and mailing had to be provided.

Fig distribution was very large over the Southern States and in California. The plants were propagated from importations received in 1890, embracing some of the noted commercial varieties of Europe, and have been appreciated by those receiving them.

Pineapple plants are greatly in demand, much beyond the ability of the Department to supply. The culture of this fruit is gradually extending, and the superior quality of the varieties sent out will in time add something to the value of this crop.

Calls for olive plants are becoming numerous, and efforts are being made to increase their propagation here, the more fully to meet these demands.

Although several thousands of camphor plants are ready for distribution, they will not more than meet the demands of those desiring to plant them.

Many thousands of the best hardy grapes and the best strawberries have been sent out. The foreign varieties of grapes are much asked for in southern Texas and in Florida.

The Japan persimmon is now, after efforts for many years to popularize its culture, well introduced and is being propagated by the nurserymen, who can supply all demands.

Citrus Trifoliata, a hardy species, which makes a novel and admirable hedge plant on account of its thick thorny growth and small orange-like fruits, is being prepared in quantities for experimental test. Just how far north it will endure is not fully known, but it is said to be hardy as far north as New Jersey.

NOTES ON HORTICULTURAL AND KINDRED SUBJECTS.

CUTTINGS.

Letters frequently reach the Department asking advice relative to the management of outdoor cuttings of hardy plants, and describing failures in attempts to propagate plants that grow with the greatest certainty when properly managed. On inquiry it is learned that these failures result from improper planting; cuttings of grapes, for example, 12 inches or so in length, planted one-half of their length, fail to grow owing to the large portion which is thus exposed to the air, exhausting the sap by evaporation. Cuttings made of matured growths should always be set so that their entire surface is covered with soil. A successful method is to press the cutting down in well-loosened soil until its top is level with the surface; then cover it over with a couple of inches of sand, the cuttings being about 6 inches in length. Except in the more northern localities, these cuttings succeed best when set during the month of October; not later, unless in Southern States. Plants that ripen the young growths early in autumn, although the foliage still remains on them, may be prepared by removing the leaves, as early as September. Cuttings of currants thus treated and planted about the middle of September will be rooted before the end of December. Fall-planted cuttings, in addition to the covering of sand, will be further helped by a coating of manure whenever the thermometer falls below 10° F.

Some of the plants which can be propagated by this method are the following: Among pears, the Le Conte, Kieffer, Garber, and others of this class; ot plums, the Mariana and many of the Japan kinds; quinces, grapes, currants, and gooseberries; of trees, maples, poplars, willows, mulberries; among shrubs, Forsythia, many of the Spiræas, Weigelas, Privet, Hardy Hibiscus, etc.

Some plants that are otherwise difficult to propagate can be increased by using cuttings of their roots. Among these may be mentioned raspberries, Japan quince, Osage orange, and the crape myrtle.

The roots, cut in 3-inch lengths, are spread thickly on the surface and covered with 2 inches of soil. The best success will follow when a sash-covered frame is employed as a protection, and the soil used for covering is of a sandy texture; pure sand is preferable.

CINCHONAS.

Inquiries are received asking what progress, if any, the Department has made toward introducing and fostering the culture of these quinine-

bearing trees. The suggestion has also been made that an expedition be fitted out to explore the regions in Peru and Bolivia where the trees are indigenous, so that the climate of their habitats, the soil in which they grow, the elevation at which they are found, and other facts connected with their life history may be ascertained, with a view of locating proper regions for their culture in the United States. As to the value of this investigation, it was suggested that the published results of botanical and other travelers concerning these trees in their native state left nothing further to be learned that would be of practical value.

In regard to the efforts of the Department in the introduction and dissemination of the cinchona, it is stated that for more than twenty years it has been possessed of young plants of the most valued species, and many thousands have been sent to various parts of the States where there seemed to be even the faintest likelihood of their growing, but no such place has been found. There is no encouragement at this time for further efforts. Even if a suitable location for its culture could be found, the low prices at which quinine can be purchased would prevent any one from attempting its production.

Even in Jamaica the government plantations of cinchona can find no profitable sale for the bark, and private owners of plantations in that island have abandoned them, after severe losses. The supply from British India has reduced the price of the article so much that the higher-priced labor of the West Indies prevents further competition.

COFFEE.

Although the Department has for some time past been very well convinced that the culture of coffee can not become a matter of importance in the United States, yet (for the same reason that tea plants are kept on hand for distribution) a supply of young plants is maintained and distributed in localities where they may be grown for domestic purposes. Further than this coffee-planting is not encouraged. There are some localities in the southernmost parts of Florida where coffee berries will ripen, and in such localities they may be prepared for domestic use.

COCA, COCOA, OR COCO.

These terms are used indiscriminately for a number of plants or their products. Coca properly belongs to *Erythoxylon Coca*, the leaves of which, known as coca leaves, have long been used as stimulants by the Peruvian Indians, and have lately been used for the extraction of a principle called cocaine, which is used as a nervine.

The Chocolate plant, *Theobroma Cacao*, is highly valued for the produce of its seed, variously known as cacao, cocoa, and coco. In this case cacao is the proper term to use when describing the plant or its products.

Cocoa is properly used in connection with the nuts produced by the palm tree *Cocos nucifera*, known as cocoanuts.

Coco is used in describing the roots of *Caladium esculentum*, *Colocasia antiquorum*, and other species of both of these. The roots or root-stocks, being filled with starch, furnish an article of diet throughout many tropical countries, where they are cultivated for that purpose.

Choco and coco are terms applied to the products of *Sechium edule*, a climbing plant cultivated in the West Indies and other warm countries for the sake of its fruit. Its roots, known as coco-roots, are large and

have the appearance of a yam, which they resemble in taste when cooked. The fruit is said to be wholesome and fattening.

WATER FOR PLANTS IN POTS.

Rain water should always be used for plants when it can be obtained. The water from the roof of a greenhouse, if it is all carefully collected and economized, will usually supply all that the plants in the house will require.

Next to rain water, that from a river is preferable, although oftentimes muddy and unfitted for sprinkling over leaves. Water pumped from wells should be aërated before used on plants. Tanks of ample capacity should be provided and placed in the house, so that the water may approximate in temperature to that of the atmosphere surrounding the plants. Heated pipes are often introduced into such tanks, heating the water up to, or slightly over, the temperature of the house.

OSAGE ORANGE.

This plant, *Maclura aurantiaca*, is familiarly known as a hedge plant in most parts of the country, but it has other useful properties. A decoction of the wood yields a beautiful and very permanent yellow dye; and this decoction, carefully evaporated, forms a bright yellow extract called aurantine, which may be used in imparting its color to fabrics. In addition, the wood is rich in tannin. Experiments made in Texas, where the tree is plentiful, represent that hides are tanned quicker with its wood than with oak bark. Its seeds yield a bland, limpid oil, resembling olive oil; and, lastly, the leaves are a valuable food for silkworms.

Another species, *Maclura tinctoria*, is a native of Jamaica and tropical South America, where it is known as Fustic. Its bright yellow wood is much used by dyers, who obtain from it shades of yellow, brown, olive, and green colors. The wood is close and tough grained, used in carriage-building. This tree is sometimes called old fustic, in order to distinguish it from another commercial dye called young fustic, which is obtained from a European species of *Rhus*.

PROTECTING PLANTS DURING WINTER.

The opinion, sometimes expressed, that hardy plants need no protection during winter, is not shared in by persons who find increased crops where protection is given. It is argued by some that the strawberry, for instance, is naturally as hardy as many other plants which require and receive no protection whatever, and so with other cultivated plants, as the grape, raspberry, etc. This is true to a certain extent, and if nothing further was looked for than the mere existence of a plant, it would not greatly matter whether it received protection or not. But in practice it is found that a proper degree of covering notably increases the crops of fruit; and it is well to keep in mind that the best varieties of our fruit-bearing plants have been far removed from the natural condition of their ancestors, and have acquired artificial qualities, as it were, by careful cultivation, and which can only be maintained by constant attention to their needs. If neglected, they will soon show the ordinary result of negligence, and it is only by giving all the care and judicious attention which the best experience suggests that they can develop their greatest profit and usefulness. But it is also a common observation that a good practice may be rendered nugatory by injudicious application.

CHANGING SEED.

The advantages or disadvantages attending a change of seed from one soil or climate to other soils or climates suggest a series of questions about which comparatively little is known. Most persons engaged in plant culture admit that their products are greatly influenced by the kind of seed sown, and, so far as they can be guided by appearances, will endeavor to select a good sample for seeding purposes. External appearances, however, will not convey the exact value of the plant which may be produced; something will be due both to the soil and climate in which the seed was sown. These factors will undoubtedly exert an influence, more or less pronounced, upon the plant. But how far this influence extends, or how far it may be made subservient to the increase, the earliness or lateness, or otherwise add to the intrinsic value of crops, there is no certain knowledge. A large number of facts could be advanced to prove the existence of such changes, but they have not been brought together in such systematic form as would admit of deducing any principle of action from their tabulated results.

It is known that climates have very perceptible influences upon the habits of plants; also that these peculiarities are transmitted, with more or less degree of permanency, to their progeny. The length of time required to establish a particular habit has not been a subject of much recorded observation. It appears, from what is known, that habits rapidly acquired are as rapidly lost on the reversion of the conditions which produced them. Certain seeds, when grown in warm climates, will in one season inherit a palpable degree of earliness which is at once imparted to the plants they produce, a fact which can be made of much practical value, especially in the production of early vegetable crops.

PLANTING TREES.

The secret of getting trees into vigorous and rapid growth is in the preparation of the soil before planting. In setting trees in parks and pleasure grounds, where the surface soil is usually good for several inches at least, the material for planting is ready at hand. Make holes 6 feet across and 18 inches deep; in digging these, place the good surface soil on one side and the bad or inferior soil on the other. The hole should then be filled by first throwing in the surface soil just taken out, and collecting enough to complete it from the contiguous surface, replacing it by the subsoil, where it can be enriched if necessary. The difference in five years between trees thus planted and those merely stuck into small holes would surprise people not familiar with cause and effect in this line of operations.

Carelessness in planting will be indicated for many years by dwarfed growths, moss-covered bark, and frequently by the death of the plant after lengthened efforts to survive, while trees properly set out will proceed to enlarge satisfactorily from the first. A very old writer says that "a slovenly planter ranks among the most extravagant order of slovens; the labor, the plants, and the ground are thrown away."

THE STRAWBERRY.

The main points involved in the successful culture of this fruit are the following:

(1) Prepare the ground by deep plowing and subsoiling; apply a dressing of rotted manure equal to 20 cords per acre; spread it over

the surface, and mix it with the soil by repeated disintegration with a harrow. The best crops are produced on strong, loamy soils; if somewhat clayey it will be all the better, provided it is drained.

(2) Allow the plants plenty of space; the rows 30 inches apart, and the plants about half that distance between each other in the rows.

(3) Remove all runners as they appear, and keep the surface pulverized and clean. If young plants are wanted, keep a portion of the plantation for that purpose.

(4) Cover the plants in winter in all localities where the thermometer may run down to 10° F.; this to be done after the first frost, using straw, leaves, or other similar material as a partial protection.

(5) Do not disturb the roots, by any process of cultivation, from the month of September until after the crop has been gathered the following summer.

(6) Destroy the plantation after it has produced its second crop, new ones being planted to succeed those that are abandoned.

DRAINING "HARD-PAN" SOILS.

A correspondent writes as follows:

> I have a field which is underlaid by a thin stratum of hard-pan about 18 inches below the surface. The soil is good, but wet; sometimes it will be almost muddy for weeks at a time. I have thought of laying drain-pipes on the top of the hard-pan; do you think that this would take off the water?

To this it was answered—

> Laying the drains as proposed would undoubtedly carry off the surplus water, but it has been stated that when the tile is laid below the hard-pan the effect of alternate soaking and drying will, in a few years, so change the whole texture of this hard strata as to render it porous and friable and easily accessible to the roots of plants.

The value of draining lands, especially clay soils, is now recognized even by cultivators who heroically maintained that while draining lands might be essential in wet climates it was not necessary in this; that under our bright sun and rainless skies the trouble is want of water rather than excess of it. As knowledge spreads these conclusions are seen to be erroneous, and they begin to realize that a soil well drained is also well aërated, and that drains remove surplus water only, and thus allow the admission of air, which carries suspended moisture to plants just when and where they most need it, so that a dry season has but little effect upon their growth. A drained soil is fortified against either of the extremes, wetness or dryness. This has been so often demonstrated and so frequently advised that it would seem unnecessary to adduce further proof of its value.

ALTITUDES FOR FRUIT TREES AND GRAPE VINES.

In a letter from a correspondent, in reference to fruits, etc., the following sentence occurs: "Noticing what has been said about high lands for fruit trees and grape vines, I would state that we are some 300 feet above tide water, which, I presume, is sufficiently elevated to insure success." To this it was replied that it is altogether unnecessary to pay any attention to sea level in choosing sites for orchards or vineyards. The elevation needed is a local one, and high enough above the valley to admit of the colder air finding its way down the hillside and taking the place of the warmer air, which is raised up in consequence. Wherever this warm air impinges there will be no dew, and colds less severe than

in the lower grounds. Under some configurations of hill and valley the thermometrical difference between them is quite astonishing. A difference of one degree for every 4 feet of elevation has been noted, so that plants may be destroyed in the low grounds, while others of the same kinds not more than 60 feet above them may escape uninjured. These differences give rise to many seemingly conflicting statements in regard to the hardiness and general success of plants. It also leads to extremes in choosing sites for fruit orchards. While a low, sheltered valley may be the worst place to select, it does not follow that a bleak elevated northern exposure is the best.

PACKING THE SOIL AROUND ROOTS AND SEEDS.

Failures in transplanting trees more frequently occur from what might be termed loose planting than is supposed. In setting a tree, dryish and pulverized soil should be used, and this should be pressed among the roots as firmly as may be done, so that the young fibers may strike at once into solid soil. Even in potting plants, with soil in proper condition it can not be made too firm, if nothing harder than the hands be used. It is oftentimes necessary to use a small rammer to make the soil sufficiently firm, especially when changing a well-rooted plant from a small to a larger pot. The benefit of pressing the soil over newly sown seeds is not so well known as it should be. Under some conditions of weather it makes all the difference between success and failure. Firming soil around seeds and plants is evidence of good culture.

BRUSSELS SPROUTS.

To the majority of our people this vegetable is unknown; they have never seen this, the sweetest and most palatable of all the cabbage family. The plant forms a small, rather loose and open head, with somewhat wrinkled leaves, similar to those of the kind of cabbage known as the Savoy.

The peculiarity of the Brussels sprouts consists in the buds, which are formed at the axils of the leaves. In the common cabbage these buds do not push into growth until the second year, and then they run to seed stems; but in the case of the Brussels sprouts these buds push out thickly all over the stem the first year of its growth, and so closely together that the stem is completely covered with them. These buds form neat, miniature, compact cabbage heads. The original leaves of the plant drop off as the stem lengthens and the buds enlarge. These small heads are sometimes 3 inches in diameter; they are finely flavored, and in great demand when once their value is recognized. They succeed wherever any of the cabbage family will grow, and their culture does not differ from that bestowed upon the common cabbage.

RIPENING OF FRUIT.

It is known that the best flavored, best colored, and finest specimens of fruit are those which have ripened on plants having an abundance of healthy foliage, where the fruit could be entirely screened and shaded by the leaves. The finest strawberries are those found in the densest foliage, and so with grapes and other fruits. Yet the question is occasionally submitted as to whether or not the leaves should be removed from bunches of grapes, so that their maturity might be hastened from exposure to the sun. It has been advised as a necessity, and that it is

a rule to do so in some European vineyards. To all this it may simply be said that the removal of leaves never yet improved the quality of fruit or hastened its healthy maturity.

Exposure to the sun will sometimes effect a premature coloring in grapes, but the mere coloring is not a sign of maturity, although it indicates approaching ripeness. The only true indication of a ripened bunch of grapes is when the shoot upon which it is growing has turned brown and hard. Pulling the leaves from figs, grapes, or any other fruiting plants with a view to assist in ripening their crops is a fatal error, because it has the opposite effect.

TRAPA NATANS.

This pretty and interesting aquatic plant has been introduced in ponds in various parts of the country. The plants have long, jointed foot-stalks, with tufts of hair-like roots at their joints, surmounted by a roseate cluster of floating leaves, having the petioles inflated into a tumor, to buoy them up. The fruits are hard, with four projecting spines resembling the spiked iron instruments called caltrops, which were employed in ancient warfare for strewing on the ground to impede the progress of cavalry; hence the plant is known as "water caltrops." The seeds are farinaceous, and are considered nourishing. They are ground into flour and made into bread in southern Europe. They were used as food by the ancients.

The Ling or Leng of the Chinese, *Trapa bicornis*, has a fruit with two projecting curved horn-like spines, like a bull's head. The Chinese eat the fruit and cultivate the plant in marshes.

Another species, *Trapa bispinosa*, is cultivated in eastern Asia for its edible nuts. They are called Singhara nuts in Hindostan. All these nuts abound in starch.

PEACH BLISTER.

A correspondent asks for the names of six or eight peach trees that are not subject to leaf blister. No such list can be made, as all varieties are liable to this disease when the atmospheric conditions exist which cause it. These conditions are sudden changes from heat to cold at a time when the leaves are just appearing, or when quite young. Oftentimes some varieties will escape because of their earliness or lateness; but while late pushing varieties may escape this year, when earlier kinds may be badly blistered, it may happen that next year the reverse will occur, and late varieties suffer when early kinds are exempt. Protection will prevent it. In favorable seasons all varieties are exempt.

The blister has been attributed to aphis because these insects are found on the leaves; they may be found occasionally, but not always. Leaves attacked by aphis shrivel and curl, but they do not blister.

SOIL FOR PLANTS IN POTS.

Once upon a time it was considered essential to have a different mixture of ingredients for each class of plants, and in old gardening books these receipts form a considerable portion of their contents. Of course much of it was purely fanciful, as is proved from the fact that equally good, if not better, results are now obtained with simpler ingredients. The staple for good potting soil is rotted sods. These should be cut from old, tough meadows which have been for years in

grass, and should not be over 2 inches in thickness, and piled in a heap for two or three months before using. The fibrous matter they contain furnishes the best kind of plant food. The only addition required may be a portion of sand, and this only when the sods have been taken from clayey soil.

SUMMER PRUNING OF GRAPES.

The practice of pruning grapes during summer has been much reformed of late years, and some vine-growers advise its entire abandonment. There is an advantage to be gained by pinching out the point of a fruiting shoot, two or three joints above the bunch, if done early, so that the portion removed is a mere point displaced by the finger and thumb. This tends to check the longitudinal growth for a time, and has a tendency to strengthen the fruit stalk. So far this is well; no harm is done to the growth of the plant, but when the shoot is allowed to extend two or more feet, and then all of it removed to within two or three leaves or joints of the fruit, a great injury has been done. Vineyards have been destroyed for the season, and the crop lost, by summer pruning which involved the removal of a large quantity of active foliage, thus completely checking further growth for the year.

VINES ON WALLS.

The opinion is somewhat prevalent that vines on walls encourage, and indeed produce, dampness. Close observance proves that walls covered with vines are drier than are those where no such covering exists. A moment's reflection would suggest that a thicket of leaves acts as a thatch, throwing off rains and keeping walls dry; they also have the further effect of preventing walls from being heated by the sun, so that in the case of dwellings where the walls are covered during summer the rooms are perceptibly cooler in consequence. The ivy (*Hedera Helix*,) in climates suited to it, is probably the finest evergreen for clinging to and covering walls; but the persistency of its foliage has been objected to, inasmuch as it prevents the sun from warming the walls during clear days in winter.

A vine which possesses an abundance of foliage in summer and becomes deciduous in winter is therefore to be preferred, and the best plant to meet these requirements is the Japan ivy (*Ampelopsis tricuspidata*). This plant is nearly allied to the Virginia creeper, which adorns and enriches the woods with its rich autumn colors.

The Japan species has exceedingly delicate foliage when young, although the leaves become larger and are supported upon longer footstalks with age; but at all times it clings tenaciously to walls, its tendrils ending in bulbous-looking points which adhere to objects as if glued or gummed. Its foliage does not present the autumn brilliancy of the native species, although it occasionally becomes well colored. It also appears to have a tendency to lose portions of shoots during winter, but blanks thus made are speedily covered with a new growth which is always more beautiful than the old.

TREES IN CITIES AND ON STREETS.

Perhaps in no one particular does the city of Washington, D. C., stand out so conspicuously among other cities as in the matter of trees. It is acknowledged by those whose extended travel and intelligent observation qualifies them for the expression of opinions on this point

that Washington is the best-planted city on this continent. From exact data it is shown that if all the trees set out in this city during the past twenty years were placed 25 feet apart they would make a solid block of upward of 1,200 acres of forest.

Having watched the progress of this work from its inception, and being familiar with all its operative details, much of the subject-matter of the following pages will have reference to the successful methods employed in its performance and prosecution.

ADVANTAGES AND DISADVANTAGES OF TREES IN CITIES.

The effect of trees in cities, whether injurious or beneficial to health, is a subject upon which some of our more advanced sanitarians do not fully agree in all particulars.

It is admitted that the constant evaporation of moisture from their foliage during dry sunny weather has a decidedly cooling effect upon the immediately surrounding space, thus imparting a balmy influence to an atmosphere rendered arid by contact with heated surfaces of stone and brick. The water required for their sustenance having to be absorbed from the soil, it is thus drained of much superfluous moisture, keeping the ground dry about foundations and cellar walls, and thus far contributing to the healthy surroundings of dwellings. Independent of these sanitary results, the decorative beauty of trees is nowhere more conspicuous or more impressive than when contrasted with the hard monotonous lines of ordinary city architecture.

Although shade is sometimes exceedingly agreeable near a house, yet it is not advisable to have trees so close as to form a constant shade on the house itself. It is much more preferable that the sun should shine on the walls than that they be always shaded from its direct rays. It is a common belief that too much shade around a dwelling is conducive to ague, but medical records assert that trees do not seem to influence this malady in any degree. Instances have been given where dwellings heavily shaded by trees were free from the disease, while in the same neighborhood houses entirely destitute of trees were full of it, and the reverse of this is also said to exist.

Notwithstanding the above, it is not disputed that unhealthy influences are induced and fostered in dwellings where proper ventilation is retarded by dense tree shade. Moss-covered walls and roofs, and alleys constantly damp, are clearly indications of interrupted ventilation. Heat is the primary factor in ventilation. Without this prime motor we can have no appreciable movement in the atmosphere, and where the rays of the sun are intercepted by the foliage of trees this healthful movement in the air is reduced to a minimum, and dampness, with its never-failing accompaniment of a sickly atmosphere, pervades the cool overshaded dwelling.

The evils resulting from overplanting of trees close to dwellings may be observed in many of the older residences in cities and their suburbs. Planted by hands which have long been at rest, these trees are venerated for their associations. They form a connecting link between the old and the young, and he would be considered a ruthless invader who would suggest the removal of a single branch, even should it be the means of securing that benign blessing, a ray of sunshine, upon the moss-encumbered roof. While we may sympathize with the feeling that prompts to veneration of these time-hallowed relics, let us profit by the lessons it teaches, and so dispose of our shade trees that our descendants may, without injury to their health, cherish the arboreous monuments we bequeath to their care.

The greatest obstacle to the proper disposition of trees in most cities proceeds from the narrowness of the streets, or rather because of the limited space allowed between the opposite building lines. Even in the planning of modern suburban towns, where it might be supposed that land could well be appropriated for ample width of streets, sidewalks, and parkings in front of houses, the utmost penuriousness seems to prevail in this regard—a comparatively narrow street, then a narrow sidewalk, then the front walls of the house, thus completely prohibiting the practical shading of the street or the promenade without injury to the dwellings and their inhabitants; and withal, so popular is the conviction that trees are a necessity in these improvements that lines of them are set out where they can only become a discomfort and a nuisance, if they grow at all.

Trees should not be planted at a less distance than 20 feet from a building; 30 feet would be better. It should not be the purpose to shade dwellings, but to shade the sidewalks and promenades for pedestrians and yet allow ample freedom for the admission of sun and winds on the street proper, as also on the surrounding spaces; and thus, while the cooling effects of foliage will pervade the atmosphere, and an enjoyable shade be secured, ventilation will not be impaired.

SELECTION OF TREES.

Some of the principal qualities required for a suitable street tree may be noted:

(1) A compact stateliness and symmetry of general form and outline, as distinguished from a spreading or a pendent tendency, so that the stem can be relieved of side branches to a height sufficient to allow a free circulation of air beneath, and also that they may not interfere with the comfortable use of the sidewalks and streets.

(2) An ample supply of expansive foliage, of early spring verdure, and rich and varied in the colors and tints assumed during the ripening of the leaves during autumn.

(3) Healthiness, so far as being exempt from constitutional diseases, and ability to withstand the many evils which city trees have to encounter, such as reflected heat from buildings, short supplies, at times, of water, and the same of soil.

(4) Cleanliness, as characterized by persistency of foliage during the summer, freedom from fading flowers, and measurably exempt from attacks of insects.

(5) It should bear removal and transplanting without much difficulty; not liable to throw up suckers from the roots; of vigorous, but not excessive, growth. A tree of extremely rapid growth is usually short lived.

(6) The branches should be elastic, rather than brittle, that they may better withstand heavy storms and twisting gales, which are more prevalent in cities than happens in seemingly more exposed situations.

While it is, perhaps, not possible to select any one tree which possesses all of the above qualifications, we can select those species which experience proves to approach nearest to perfection, and among them the following are most available:

TREES FOR GENERAL USE.

SILVER MAPLE (*Acer dasycarpum*).—This tree, perhaps more than any other, possesses most of the qualities required in a street tree, and, consequently, is held in high estimation as such. It is easily propagated;

seeds sown in June, as soon as they ripen will furnish plants three or four feet in height the same season, and they are easily transplanted. Its growth is rapid, and of upright habit unless thrown out of its normal shape by injudicious pruning, which frequently happens. Its greatest fault is a liability to send out rival branches from the main stem, which in time will split off during storms. This can be greatly prevented by timely pruning the tree in the earlier years of growth, confining it to one central leading shoot. On account of the liability of splitting, no cutting in, or topping, of the central shoots should be permitted. If the main stem is topped a number of branches will emanate from the cut portion, forming side branches which will ultimately split apart in storms. No tree requires more care when young in diverting growth to a main central trunk, from which all other branches are subordinate. The foliage is ample, but rarely so dense as to prevent a considerable circulation of air through its branches—a very desirable quality. It is comparatively free from insects, and holds its own well in comparatively poor soil when once fairly started in its permanent location.

SUGAR MAPLE (*Acer saccharinum*).—This is the most beautiful of all our maples, and, it may be said, one of the finest of all trees. It is usually of a fine symmetrical contour, and has at all times a stately gracefulness, which is greatly enhanced by its peculiarity of supporting a massive top on a comparatively slender stem. For beauty and density of foliage from early spring to late summer, for the great variety of brilliant tints and shades of color of the ripening leaves in autumn, few trees can equal it. The sugar maple is of slower growth than the preceding species, and does not bear the effects of transplanting quite as well; but after it gets fairly recovered from the shock of removal, and started in good soil, no fault need be found with its slowness of growth. It is a very cleanly tree, not subject, usually, to be attacked by insects of any kind, and, for planting straight avenues in parks or for country residences, it is one of the best of all deciduous trees. Its massive habit of growth has a tendency to produce too dense shade for a street tree. This fault can be sensibly modified by thinning out the branches, not by merely heading in, or cutting back the shoots, but by the entire removal of a limb or branch from its starting point on the main stem. Cutting or pruning points of shoots will only result in a still further thickening of the tree, the very thing to be avoided.

AMERICAN ELM (*Ulmus Americana*).—This is a popular shade tree in many localities, although not so often employed for streets as it once was. It requires ample space and should be used in wide avenues only. It is of stately growth, and as it attains age and size acquires a certain degree of picturesque ramification in the disposition and general outline of its branches. It is exceedingly varied as to manner of growth, some specimens assuming a decidedly drooping or pendent habit, while others stretch out freely, forming wide-spreading tops. Its liability to injury from a leaf-eating beetle has much impaired its reputation as an ornamental tree in parks and lawns, also to some extent as a street tree; it is not equally subject to these insects in all localities, neither are all seasons alike favorable to their depredations, nor all positions equally suited to their increase; notably in closely paved streets, where but little of earth surface is left around the stems, the conditions for the increase of the beetle are not favorable, especially if weeds and grasses are prevented from growing up as a harbor and resort for the beetles to hibernate.

AMERICAN LINDEN (*Tilia Americana*).—This well-known native tree is of robust and lofty spreading growth and is well fitted for the embellishment of wide streets or avenues where it can have ample room, and affects the suburbs rather than the thickly settled parts of the city. It is very unsatisfactory in poor soils; must have good soil and a wide feeding range to maintain health and vigor, otherwise it will fail during dry seasons, the leaves turn brown by midsummer, and drop prematurely. It is a notably fine tree when properly placed, and, although not so dense of foliage as some others, has abundance for all necessary shade. Its flowers are sweetly fragrant and furnish valuable food for bees.

TULIP TREE (*Liriodendron tulipifera*).—This is conceded to be one of the finest of our forest trees; the unique form of the leaves, their vivid green appearance in spring, beautiful yellow coloring in fall, and the tulip-like formation of its flowers, are characteristic features of interest. It is not surpassed by any other tree in the columnar massiveness and elegance of stem and general symmetry of development. Planted in rich soil and in a favorable position it is of rapid growth, quite equal to the silver maple. It has the drawback of being somewhat difficult to transplant; its roots are fleshy, and decay upon being severed or broken. Success may almost be guarantied if the young plants are moved and replanted several times in the nursery rows before setting in permanent situation. The tulip tree is seldom injured by leaf insects if growing freely, but like other trees on poor soil its stunted growths will be attacked by scale insects. It will not flourish long unless in good surface soil, and altogether is best adapted for wide avenues, where it can be planted at least 30 feet from buildings of any kind.

SYCAMORE (*Platanus occidentalis*).—This also ranks among the trees of largest growth, and although it may be seen in its natural habitats in rich bottom lands, appearing as an uncouth and seemingly an uncontrollable subject, yet it submits to pruning manipulations better than any tree that can be named in a list of available street trees. Even large and old trees may have all branches cut off close to the main stem, and in a few years they will show perfect columns of verdure. In some parts of Europe, notably in the city of Paris, this sycamore is popular as a street tree and is preferred to the European species (*Platanus orientalis*), which is really a more compact and symmetrical plant. But the western species seems to conform better to the system of close pruning which is practiced in that city. At all events it is a preferred tree and takes to city smoke and city life better than any other; hence it has a foreign reputation as being specially well adapted for planting in cities. Although naturally of spreading growth, it can, as already stated, be kept in close quarters by pruning. After an undisturbed growth of six or eight years let the entire system of branches be cut back. Commencing with the lower limbs, prune them so as to leave stubs about 4 feet in length, then taper so that at top they will be cut in close to the stem. Treated in this style the tree will, after two years' growth, show a columnar mass of foliage of the healthiest appearance, and it will retain this shape, with but little care, for many years. This tree is easily transplanted, and is of rapid growth.

NORWAY MAPLE (*Acer platanoides*).—This is properly held in high estimation as an ornamental tree. It has admirable qualities as a street tree. It is of slow growth when compared to some others, and rather too dense of foliage for placing near dwellings; but these drawbacks can be modified by extra preparation of the soil and a judicious thinning of the branches. It is rarely injured by insects, and is of such

sturdy growth that storms do not affect it. This is a quality of great moment in cities, where sudden gusts uproot trees and twist off branches in their course. It is easily propagated from seed, and stands transplanting without loss.

TREES FOR SPECIAL USE.

For general use the above list is sufficient for all practical purposes; but there are several other trees possessed of qualities which render them of value in particular cases. Where a rapid lofty-growing tree is desired, the Carolina poplar (*Populus monilifera*) will fill the requirement. This is a cleanly tree, except that in some places it drops many of its leaves during late summer. It is too large for narrow streets, and does not bear the pruning back of large branches so well as the sycamore, for example—that is, it looses its identity and forms only a bulky mass of foliage, which tends to its destruction during gales, its roots being brittle. This may be termed a sanitary tree in so far that its rapid growth and abundant foliage absorb much water, thus indicating its fitness for wet, marshy situations.

Another tree of rapid growth is the Negundo, or ash-leaved maple (*Negundo aceroides*). The main objection to this tree is its eminent liability to attacks of caterpillars; otherwise it is a good street tree, shade not dense, and the foliage in early summer of a lively green. It is easily propagated and transplanted; but the insect objection prohibits its use in cities.

The Ginkgo (*Ginkgo biloba*) is an interesting tree and one well adapted to narrow streets. It is pyramidal in growth; has never been known to be injured by caterpillars, or insects of any kind. The peculiar formation of its leaves and the fleshy fruits occasionally produced are of attractive interest. Many of the older trees of this species now in this country bear nuts, from which plants are easily produced.

The sweet gum (*Liquidamber styraciflua*) is a singularly beautiful native tree, both in regard to its finely shaped pointed leaves, its cleanly bright summer verdure, and its beautiful fall colorings, in which respect it is not excelled by any other tree. It is difficult to transplant, and should be prepared for this operation when young by frequent removals in the nursery. It is a large tree in good soil and in low, damp situations, but is easily kept in due bounds by timely pruning.

The horse-chestnut (*Æsculus hippocastanum*) is a well-known heavy-foliaged, massive, formal-headed tree, forming a dense shade. It surpasses most other trees in the beauty of its early summer verdure and its superb clusters of flowers, which are succeeded by large conspicuous seed-pods. This latter is not particularly to be favored in a street tree, for it is found that where either flowers or seed vessels are very conspicuous they are likely to be pulled at and destroyed. The horse-chestnut completes its seasonal growth of shoots in three or four weeks after vegetation commences. In dry summers, or if planted in poor soil, the foliage will turn brown and drop before the end of summer, making much litter by its falling leaves. On strong deep soil it is more satisfactory in every respect.

Some of the oaks are well suited for street trees. The opinion prevails that oaks are of slow growth, but those who have planted largely of oaks and compared them fairly with other trees do not indorse this opinion. Many of them are to be classed with rapid-growing trees, equaling any tree mentioned in the above list, with the exception of the Carolina poplar and the silver maple.

The willow-oak (*Quercus phellos*) forms a handsome tree, generally compact in form, and seldom, unless in very old trees, having much spread of branches. It is always a notable plant on account of its leaves, which closely resemble those of a willow. It does not produce dense shade, hence is well fitted for a city tree.

The pin oak (*Quercus palustris*) is naturally a handsome, shapely-growing tree, having numerous spray-like branches, which droop in an airy and graceful manner. Neither of these oaks are of particularly rapid growth. In this respect they resemble the sugar maple; but they are trees well adapted to city streets if furnished with a liberal supply of good soil.

Scarlet oak (*Quercus coccinea*) is quite a fast-growing tree, and particularly well adapted to plant in wide avenues; perhaps there is no tree more so. It has large foliage, of a bright green color during summer, turning to a lively bright scarlet in the fall. Altogether it is a tree of much beauty.

PREPARATION OF THE SOIL.

The fundamental requisite upon which success in tree-growing almost wholly depends is that of the preparation of the soil. In grading streets and avenues there will be more or less of cutting down and filling up, and, in either case, the original surface soil is rendered unavailable, being either removed by cutting down or covered by filling up. Wherever cutting down removes the surface soil a barren subsoil will be reached quite unfitted for tree growth. It then becomes an absolute necessity to make liberal provision for the future well-being of the tree, seeing that its sustenance for years will be derived from the preparation made before planting. In such cases holes 8 feet in length, 2 or 2½ feet in breadth, and 2 feet in depth should be excavated and the contents removed and substituted with good soil. This soil should be evenly spread over the bottom in a layer not more than 6 inches in depth and evenly, and thoroughly well tramped, and so on with similar additional layers until completed. It is not advisable to mix any kind of manure with the soil, or undecomposed organic matter of any kind, as its decay causes an undue sinkage in the future. This size of hole and quantity of soil will give the tree a good start in life, and will insure satisfactory growth for five or six years at least; then, in most cases, the roots will extend into the ordinary surrounding soil, even if it is not of the best description. There is a wide difference in trees in this respect. Some of them, such as the linden and tulip tree, will usually show by their restricted growth and early casting of foliage that their roots have reached the limit of soil efficiency, and that an extension of the holes and a supply of good soil is indicated to keep up a reasonable growth. Afterward, when such indications appear, applications of ordinary manures or bone dust may be spread on the surface, and, slightly forked into the soil, will show marked beneficial results.

On ground that has been filled in the preparation should be the same as where it has been cut down, but it will rarely be found necessary to supplement the original preparation, as the roots will readily penetrate the soil used in the filling up, and prosper, even if it is not of specially fine quality; the mere fact of its improved physical condition, resulting from the operation of filling in, rendering it more congenial to the extension of roots.

In some cities it may be found that both the sidewalk and street are

covered with concrete pavement. With holes prepared as directed, trees seem to flourish quite as well under these conditions as any others. On a brick sidewalk the water from rains percolates between the bricks, which also absorb a certain amount of moisture which can be utilized by the roots beneath. This does not occur to the same extent where the pavement on all sides consists of concrete; consequently the only supply of water is what may be received on the limited area of surface around the tree. This would appear to afford a meager supply, but there is an amount of available moisture under these close pavements which affords a sufficient supply to roots. It is a common observation that trees flourish as well under such conditions as do those seemingly much better located.

Where the width of the space donated for sidewalk admits, the expedient of leaving an unpaved strip two or more feet in width next to the curb, in line with the trees, is occasionally adopted. This space is not utilized for promenade purposes, and it adds that much more soil area which can be improved by removing portions of the sterile subsoil and supplying ground more fitted for the nourishment of roots.

PREPARATION OF THE TREES.

In cities where street planting is prosecuted systematically, and keeps pace with street extension, a tree nursery should be established. This will prove economical in many ways; the kind of trees required will always be on hand and in the best condition for setting out. Most of the trees are easily and quickly propagated from seed which is not difficult to procure. The strongest reason for a city nursery lies in the facilities it affords for the preparation of the trees when young.

The first removal from the seed rows should take place when the plants are from 18 inches to 3 feet in height, and from one to three years old. They are then set out in rows, where they may, with some exceptions, remain until needed for their permanent station. Those noted as being difficult to transplant need to be removed again after two years, and treated as before. After one year they will be ready for final removal.

A preparatory nursery is useful even for trees that may be obtained from regular tree-growers, or from nurserymen. In this case they may have to undergo various casualties between the time they are lifted and packed and the time of arrival at their destination, and some of them may be in poor condition for planting in streets. These should, as received, be set out in nursery rows, where they remain one year to recover and recuperate.

Those of them that survive can be removed with success, so that when they are set in the street no blanks will occur. A rigid following of this method shows that not over 2 per cent will require replanting, and even this small percentage is due to casualties, which trees in cities are specially liable to meet. It enables an intelligent selection to be made of such trees as are in best condition for removal; and, as none but healthy well-rooted trees will be chosen, the chance of failure is reduced to a minimum.

While the young trees are growing in the nursery, attention will be necessary as to pruning and training. Anything required in this line will have for its object the preservation of a well-defined central leading shoot. Should side branches appear to dispute the vigor of growth with this shoot they should be pruned back, but not removed entirely

until later on. The preservation of side branches tends to strengthen the main stem, and are therefore to be encouraged to a certain extent, but always subordinate to the main stem. When the tree is set out in the street all side branches will be wholly removed to a height of at least 6 feet. It is seldom necessary to prune the leading shoot, but where the growth is more than 30 inches for the year it will be advisable to remove at least one-half of the shoot, so that the smaller side branches may further assist in strengthening the stem. But this pruning of the central shoot must be confined only to the yearly growth. It should not be cut so far down as to include the older wood. If this is done more care will be required to see that a leading shoot is encouraged; otherwise a number of shoots will proceed from the top, all claiming mastery of growth.

DISTANCE APART.

A common mistake in street planting is that of placing the trees too closely together. Trees of the largest size—such as lindens, elms, sycamores, silver maples, and the tulip tree—should be 45 feet apart. The Norway maple and all of similar growth may be set at distances of 35 feet, and this is quite close enough for any kind of tree in the street. This allows each tree room for expansion, and avoids the evils of too great a density of foliage and total exclusion of sun rays—evils which are apt to develop into intolerable nuisances, depriving dwellings of the sanitary influences of air and light. Too much shade is a veritable evil.

TIME TO PLANT.

It will be readily understood that the best time to transplant deciduous trees is during the period between the fall of the leaves in autumn and the bursting of the buds into leaf in spring. In many portions of the United States there is perhaps but little choice as to the particular week or month during the above interim, beyond that of choosing a time when the soil is in good condition. In regions where the winter is well defined and much cold prevails, the planting period is divided into two seasons, fall and spring, and the relative advantages of these seasons may be briefly considered.

Other things being favorable, fall planting is preferable to spring planting, and for the following reasons: It is found that the best conditions for hastening root formation in cuttings of any kind is to keep the soil into which they are inserted several degrees warmer than the atmosphere surrounding them. This arrangement encourages root growth in the warm soil, and the cooler atmosphere prevents the growth of buds or leaves until after roots have been produced.

There is a certain period of the year when these conditions of soil and atmospheric heat are found naturally. During the month of October the soil from 12 to 16 inches below the surface will average several degrees warmer than the air 4 feet above the surface of the ground. Consequently a tree planted about the middle of October will immediately commence root growth. In the northern regions where the winter season commences early and continues long and severe, fall planting will not so generally be successful as in more temperate climates.

In spring planting it is well to have it done as early as practicable in March, or as soon as the soil becomes dry; planting can not be done properly when the soil is wet. At this planting the trees should be pruned back more closely than is found necessary in the fall.

PLANTING.

As a matter of course, the trees are to be taken out of the nursery grounds with care, securing as many of the strongest roots as practicable. Small fibrous roots are not particularly cared for, as they are of but little use for future growth; indeed, most of them will decay, and new roots push out of the older and firmer portions of the thickest roots. The instructions frequently given as to the great value of saving the small fibrous roots when transplanting a tree have no merit, for the reason given above, that they speedily decay.

Bruised or lacerated ends of roots, especially on soft and fleshy roots, should be cleanly cut across, which will tend to prevent their decay until growth becomes established. The branches will be shortened by pruning the young shoots more or less. In general, it is a good rule to cut these so as to leave about a couple of inches from their starting point, and all side branches should be completely removed up to a height of 6 feet, leaving this much of clear stem.

After the plants are lifted the roots should not be exposed to the sun or to drying winds. This may be measurably prevented by placing the trees, as soon as taken out of the ground, in a deep-sided wagon, standing them upright, properly secured from swaying, and with damp straw freely packed between and over the roots. In this manner they are conveyed to the holes previously prepared for them, and planted one by one directly from the wagon, and thus handled with the least possible exposure.

In ordinary planting a tree should not be set deeper in the ground than merely to cover the roots with 2 to 3 inches of soil; this refers to the upper tier of roots. In setting out trees in paved sidewalks they should be planted deeper, to prevent disturbance of the bricks or other pavement. Surface roots disrupt the pavement, heaving up bricks and even strong concrete coverings—such is the force of growth.

When planting a line of trees on a street or straight avenue, it is in the best taste to confine them to one species or variety as far as the line extends. Variety of trees in a planting of this kind only tends to confused irregularity. The beauty or grandeur that is produced by repetition and continuity of the same object is destroyed when a mixture of species of trees different in form of growth and diversified as to foliage are introduced, and is as much at variance with good taste as would be a mixture of orders in the columns of a temple.

BOX GUARDS.

As soon as the tree is planted it should be surrounded by a wooden box for protection against accidents and as a support. The box should be about 6 feet in height, made of strips 3 inches in width and 1 inch in thickness. These are fastened to square frames made of heavier material, one at the bottom and one at the top; the bottom frame to be 16 inches square and the top frame 12 inches square. These boxes are fastened securely by driving four stakes, one at each side of the box, in a slanting direction, and well nailed to the box. The tree is fastened by leather straps passing round its stem and nailed to the top frame of the box. Four straps will be required, one to each side. The tree will be thus secured in the central space included in the box. It is important that these straps be maintained so long as the box remains. If they are broken or removed the tree will be liable to injury by rubbing on the top of the slats while swaying about in windy weather. Trees are often ruined from this cause by the loss of bark.

For several years the box will be able to support and control the tree during storms; but after three or more years the weight of the top, especially when the foliage is wet, will loosen the box and possibly cause destruction to the tree, which, in swaying over, breaks or draws up the stakes, carrying the box with it as it leans from the storm; but when it attempts to recover, the box being rigid prevents the natural backward swaying of the tree, so that every fresh blast of wind bends it still farther, until it is eventually either broken or prostrated. So those without boxes are less liable to be blown down when 16 or more feet high than are those where this protection is attached.

A serious objection to boxes is that they furnish a refuge and a breeding place for insects. It has been noted that trees having no boxes suffer less from caterpillars than those which have, and as they are unsightly at best they should not remain longer than such time as they form a support to the tree.

City trees require protection. Horses will nibble and deface them, and malicious persons will slice the bark with knives and hatchets, so that it is necessary to provide some kind of safeguard against these depredations. As soon, therefore, as the box can be removed it will be prudent to inclose the stem, for 6 feet in height, by a wire guard. Woven-wire netting, such as used for fences, will be found to form a very neat, cheap, and efficient material for this purpose. Of course, the meshes should be small enough to entirely prevent horses from defacing the bark of the tree.

PRUNING.

The ideal street tree is one having a straight well-defined central stem through its entire height, with side branches regularly disposed around it and subordinate to it. Trees grown in this shape will withstand the fiercest storms without being injured. Not many trees naturally assume this form, but by careful pruning when young they can be made to approach it. This training process must commence as soon as the leaves fall, the first season. Some slow-growing kinds may be allowed two years before they are disturbed by the pruner, but it is essential that it be looked to while the tree is young and plastic. The operator, having a good tree-pruner in hand, should make careful inspection of the top or head, keeping in view that the main requirement is a perpendicular leading stem; it will therefore be necessary to shorten back any of the lower branches which, if let alone, would destroy the uniformity desired. This operation requires the exercise of careful judgment based upon a thorough knowledge of cause and effect, founded upon artistic recognition of the ultimate object sought to be attained—that is, a well-balanced, symmetrical, pyramidal tree.

Street trees are subjected to many casualties and hurtful influences which are unavoidable. They are rendered liable to injury from storms on account of the removal of all branches from the lower part of the trunk. This pruning is necessary in order that branches may not interfere with the use of the streets and sidewalks, but it weakens the body of the tree, and it is so much deprived of the power of resistance as compared with those whose natural growth has not been disturbed. This pruning or trimming up from below will require attention periodically for a number of years. As the lower branches extend they will drop at the ends and interfere with the use of the walk. These pendent twigs may be trimmed off, but it will be a more permanent riddance to remove the branch altogether close from the trunk of the tree.

As a rule, the worst treatment that street trees can receive is to cut their tops, "heading down," as it is termed. This kind of butchery is too prevalent, notwithstanding the palpable evils resulting from the practice. In the first place, it is a heavy blow to the vitality of the tree and greatly mars its beauty and usefulness for all time. It causes a thick, hedge-like growth of young shoots, which have to be removed, involving further pruning; otherwise a dense growth, the very reverse of what is desirable, will endanger the tree during storms, because of its density and solid mass of heavy leaves presenting an impenetrable surface to the wind. The topping tends to the destruction of many roots, rendering the prostration of the tree a very possible occurrence.

In the case of trees which have become infested with bark-lice a severe cutting down will be necessary in order to facilitate the removal of insects.

There are some trees that respond more satisfactorily from severe pruning than others. One of the best in this respect is the button-wood (*Plantanus occidentalis*). It is one of the largest trees, and is only adapted to wide spaces and should not be set within 25 feet of a building. Even at this distance its horizontal branches may reach so far as to require pruning or removal. When these interferences become altogether objectionable it is commendable to prune the tree quite severely, that is, cut every branch back so as to form a skeleton pyramid. This is best done immediately after the leaves fall and during the early winter. Commence by cutting away the lower branches to within say 6 feet of the main stem, gradually shortening this distance as the operation proceeds upward until it terminates at a point. Trees treated in this way will send out young growths at every cut regularly and evenly over the entire system, and after the growth of one year will present beautiful massive foliage, bringing out fully the pyramidal shape and increasing in beauty from year to year for many years without further attention so far as pruning is concerned.

No other tree will submit so well to this method of treatment as the button-wood. To restrain the aggressive extension of other species of large trees and keep them within reasonable bounds it will be essential to subject them to periodical inspections, repressing growths where necessary and removing branches when they become too numerous. Trees that are compact in growth, like the sugar and Norway maples, are not improved by heading in or pruning ends of branches. When these become very dense the branches should be judiciously thinned, cutting them close to the stem. If skillfully done one-half the branches of a compact tree may be removed and the casual observer would not perceive that any removals had taken place; and this should be the aim in all pruning manipulations as applied to street trees.

INSECTS.

The most troublesome insects on street trees are caterpillars, such as the fall web-worm, the bag-worm, and others. The elm leaf-beetle and scale-insects or bark-lice are also likely to be injurious; but it is only a question of labor in appliances to keep trees from material injury from any of these defoliators.

The best and the most thorough remedy is that of spraying with arsenical mixtures on the first appearance of insects. There are many excellent devices on the market for applying poisonous mixtures, the most important detail being the efficiency of the spraying nozzle that will distribute the application to the best advantage. The article known as

London purple is considered preferable to any other similar compounds, as it is less liable to injure foliage and its color facilitates its more uniform distribution. One half-pound of this substance should be used in a barrel of water. This will be strong enough to destroy all kinds of leaf-eating insects.

Where bag-worms are thinly scattered over trees, and which have escaped notice until the leaves drop, they can be removed by the pruning shears, collected, and destroyed. This timely attention will obviate more extensive efforts for the removal of the young brood during the coming season. As the bags are mostly attached to the points of small twigs, their removal in this manner involves no damage to the trees.

Much may be accomplished in destroying caterpillars by removing the webs on their first appearance, before they have had time to spread largely over the branches. The webs are at first confined to a few leaves, which may be easily removed by the pruner; but after the insects have spread over the branches they can not be removed in this way without severe and injurious mutilation of the tree. The method sometimes adopted of burning the webs with rags saturated with coal oil is not commendable. It destroys the leaves and twigs, which have ultimately to be removed by the pruner, doing quite as much damage as would result from the removal of the web-covered branches at once.

It may be noted that after midsummer caterpillars are more unsightly than positively injurious. By this time the trees have largely completed their growth extension and the wood has acquired a considerable degree of maturity and solidity, so that it is not materially hurt by the destruction of a few leaves, which in a short time would naturally drop from the tree.

Trees planted in streets are subjected to many influences tending to render them unhealthy—the roots confined, it may happen, under brick or concrete pavements; in some cases suffering from an insufficiency of water, in other cases where drainage is bad, from an excess, and the branches subjected to the reflected heat from buildings, all tending to weaken vitality and bring about conditions favorable to insect attacks to a greater extent than on trees in more exposed situations. When from these or any other cause trees get in a condition technically known as *stunted*, they will speedily become a prey to scale-insects or bark-lice, which, if not disturbed, will completely cover the bark over all parts of the tree, ultimately causing its death.

The one well-proven remedy for all sorts of bark-lice is kerosene oil. A practical method of using this insecticide is to prepare an emulsion by mixing 1 quart of soft soap or one-fourth pound of hard soap with 2 quarts of boiling water. When the soap is dissolved and while still hot, 1 pint of kerosene oil is added, and the whole well stirred until permanently mixed. When used, one part of this emulsion is mixed with twelve parts of water, and applied through a spraying apparatus. This is sufficiently strong when applied to trees still in foliage, which is not the best time for an immediate effectual destruction of the insects, because much of the mixture will be expended on the leaves before reaching the bark. Trees badly affected should be cut back quite severely after the leaves fall, or as they are about to fall, and all small twigs and minor branches removed or topped, so that the surface to be sprayed will be reduced to the main limbs, and thus easier reached.

The following formula gives a stronger and more efficacious wash: Two gallons of kerosene, one-half pound of hard soap, and 1 gallon of water. Heat the solution of soap and add it boiling hot to the kerosene. Churn the mixture by means of a force-pump and spray-nozzle for five

to ten minutes. The emulsion forms a cream, which thickens on cooling, and should adhere without oiliness to the surface of glass. Dilute, before using, one part of the emulsion with nine parts of cold water. This formula gives 3 gallons of emulsion and makes, when diluted, 30 gallons of wash.

Another method of destroying bark-lice is to cover the affected tree with common lime-wash. This application is quite effectual, and will in many instances be more readily available. This preparation is simply such as is used in coloring coarse boards and rude fences. The white color is objectionable to most people. Some coloring matter, such as yellow or dark-colored clays, may be added, enough to change the wash to a grayish tint. This also gives the wash more consistency than the lime alone, and consequently makes it more effective as a covering. As the wash is gradually removed by the weather acting upon it, the scale insects are removed at the same time, leaving a smooth, clean surface, as always results from lime-washing the bark of trees. No fear need be entertained that covering a tree with this wash will injure it in the slightest degree.

GAS LEAKAGE.

There is a loss of trees, more or less extensive, where gas pipes are laid near their roots, from leakage of the gas. The escaping gas permeates the soil and destroys the roots. Perfect or absolute immunity from this evil is probably impracticable, and, when detected, should of course be promptly remedied. The worst feature is that it is seldom discovered until damage has been done. The soil is well saturated with gas before its presence has been detected, and it is then too late for the application of any remedy, even if remedies were known, as far as relates to the purification of the soil. The best that can be done is to remove the soil, replacing it with fresh material, and plant another tree. This may not always prove successful at first, as it is a difficult matter to remove all the poisoned earth, and sometimes several removals will be required before a healthy growth is secured. It may be noted that gas-poisoned soil is the unsuspected cause of many deaths among trees in cities.

CONCLUDING REMARKS.

As a matter of cleanliness, if for nothing else, weeds should not be allowed to grow around the trees. It is essential that the surface of the holes in which they are planted should be 3 or 4 inches below the surface of the pavement, so that water from rains may have free access to the roots.

Attempts made to keep this surface lawn-like in appearance prove that it is not advisable, as the grass, even if kept closely cut, will collect dust and débris, and in a short time it will become mounded around the stem, completely throwing off water. Even where weeds are kept down, an accumulation of dust will exist and a lowering of the surface become a routine necessity.

EXPLANATION OF PLATES.

Plate I. Fig. 1. Tree just removed from nursery, newly planted, pruned, and boxed. Fig. 2. Red oak three years after planting.
Plate II. Carolina poplar not pruned since setting out.
Plate III. Carolina poplar severely headed back.
Plate IV. Silver maple not pruned since setting out.
Plate V. Silver maple after severe heading back.
Plate VI. Sycamore three years after very close pruning.
Plate VII. American linden, showing wire guard.

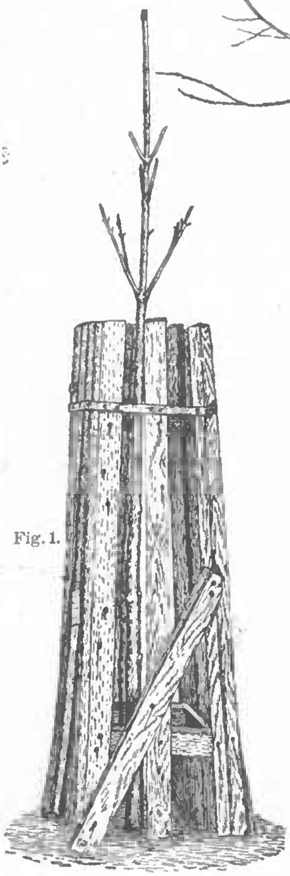


Fig. 1.

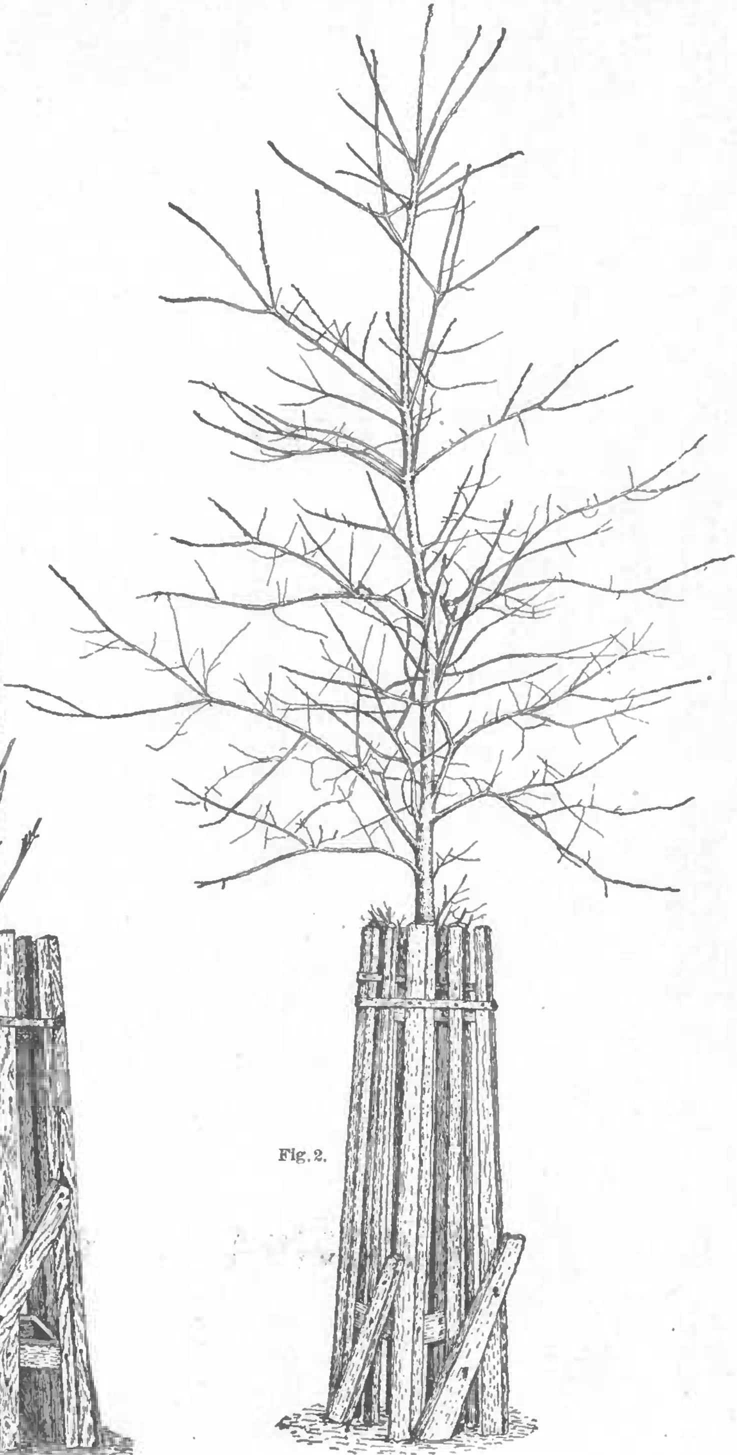
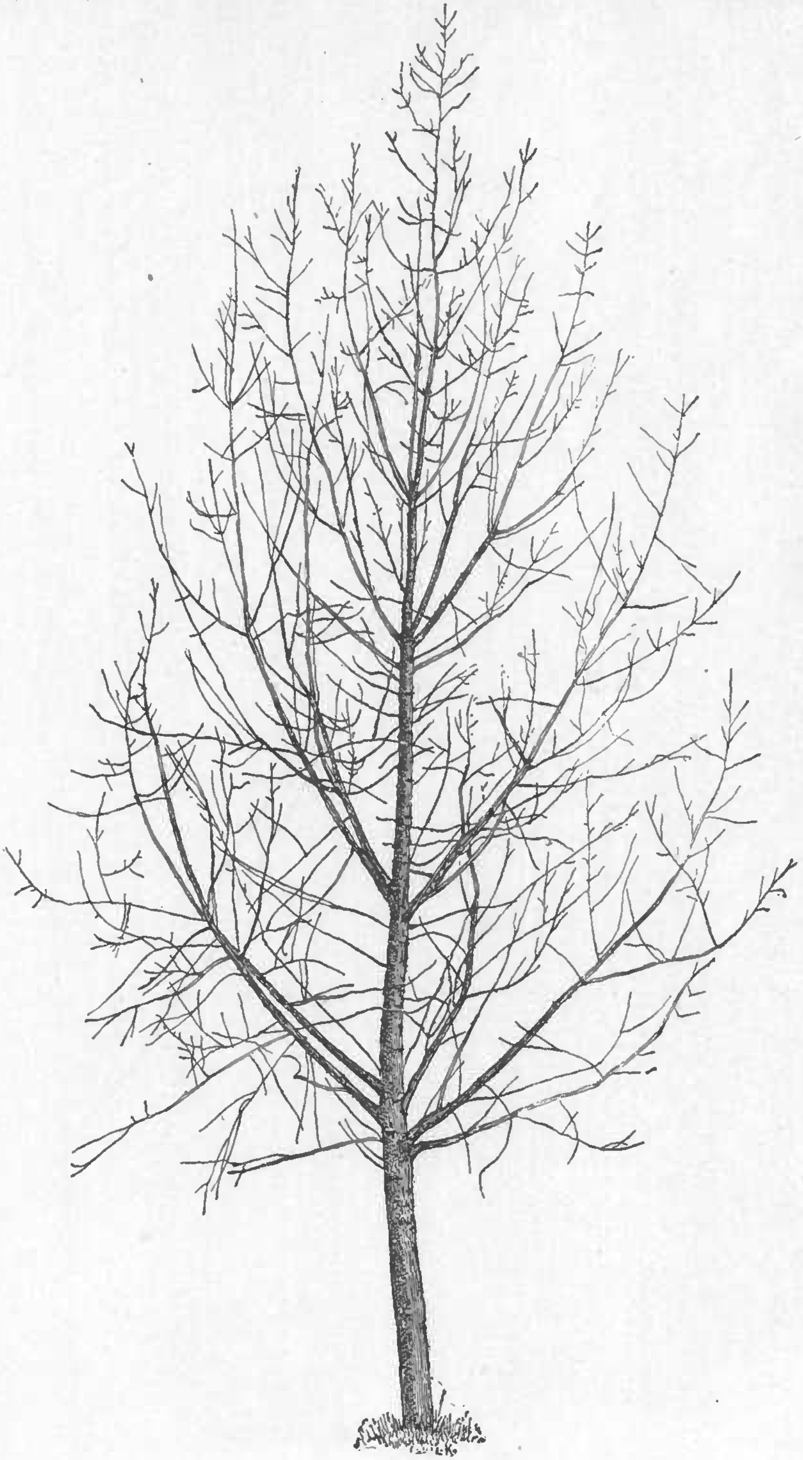
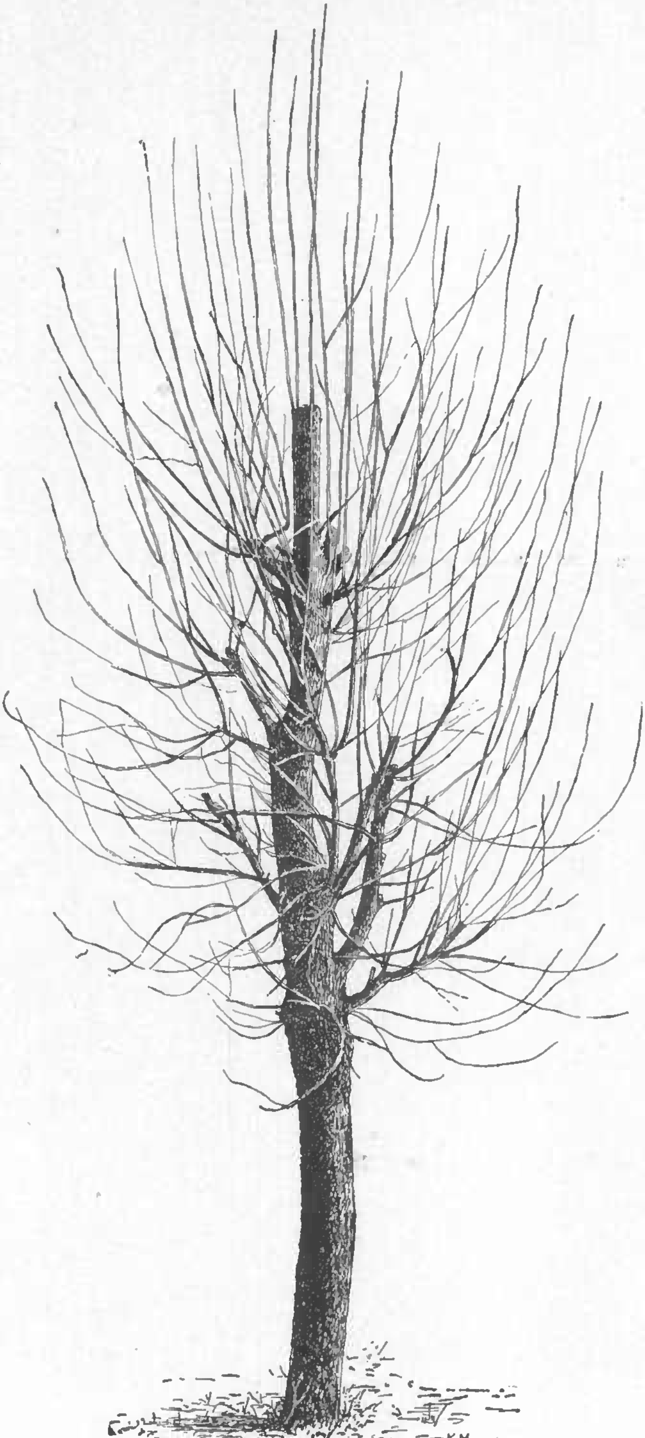


Fig. 2.

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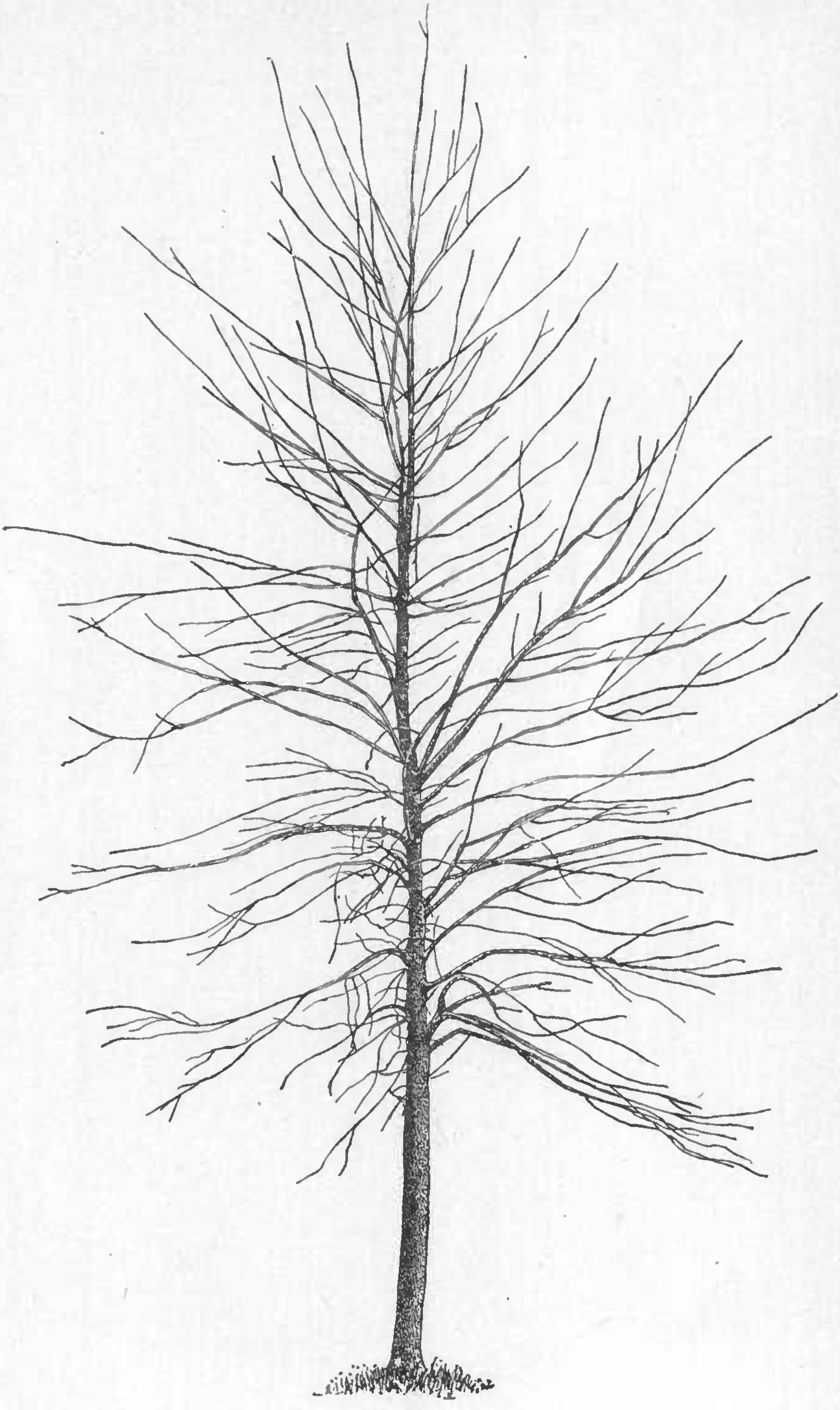
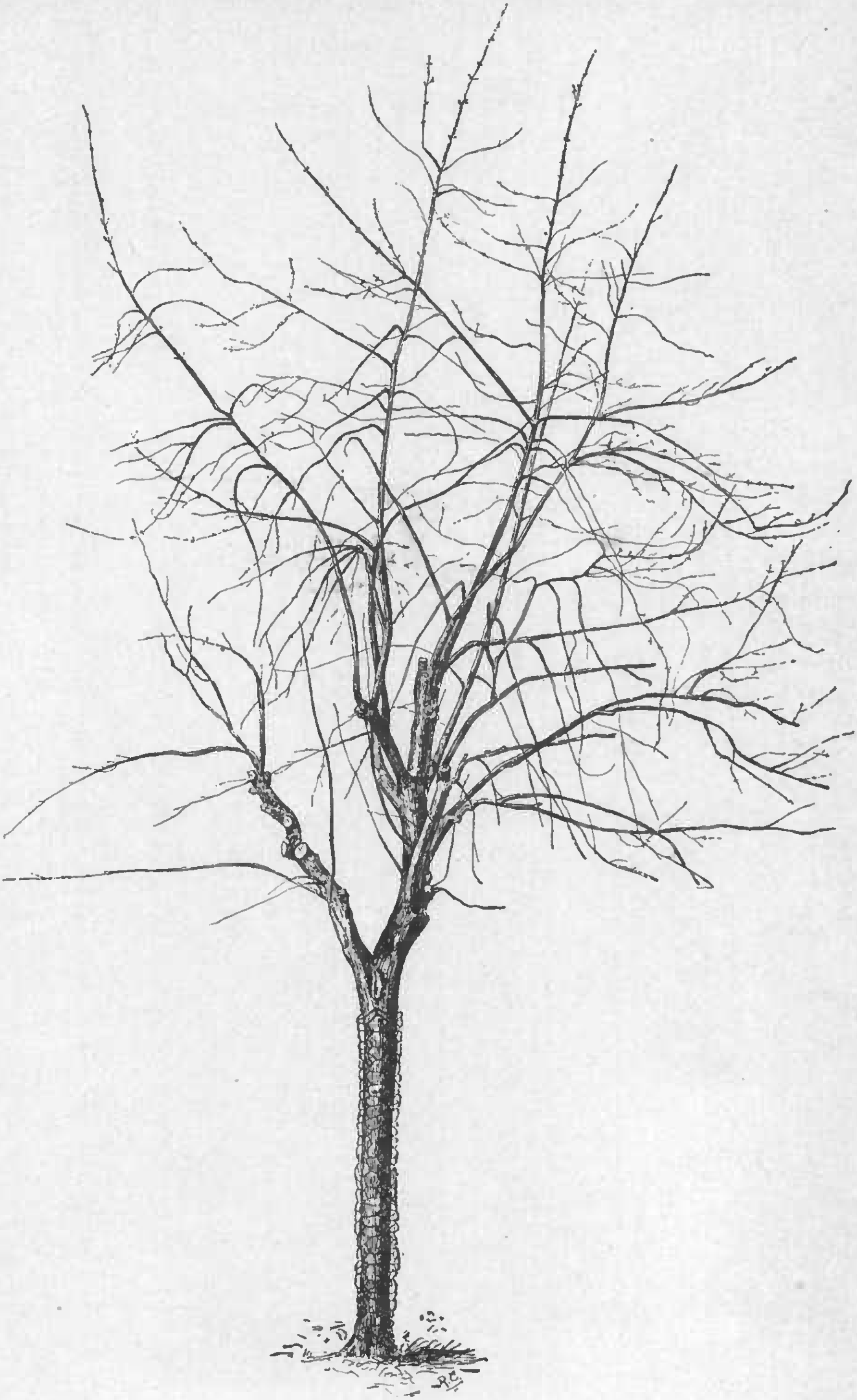
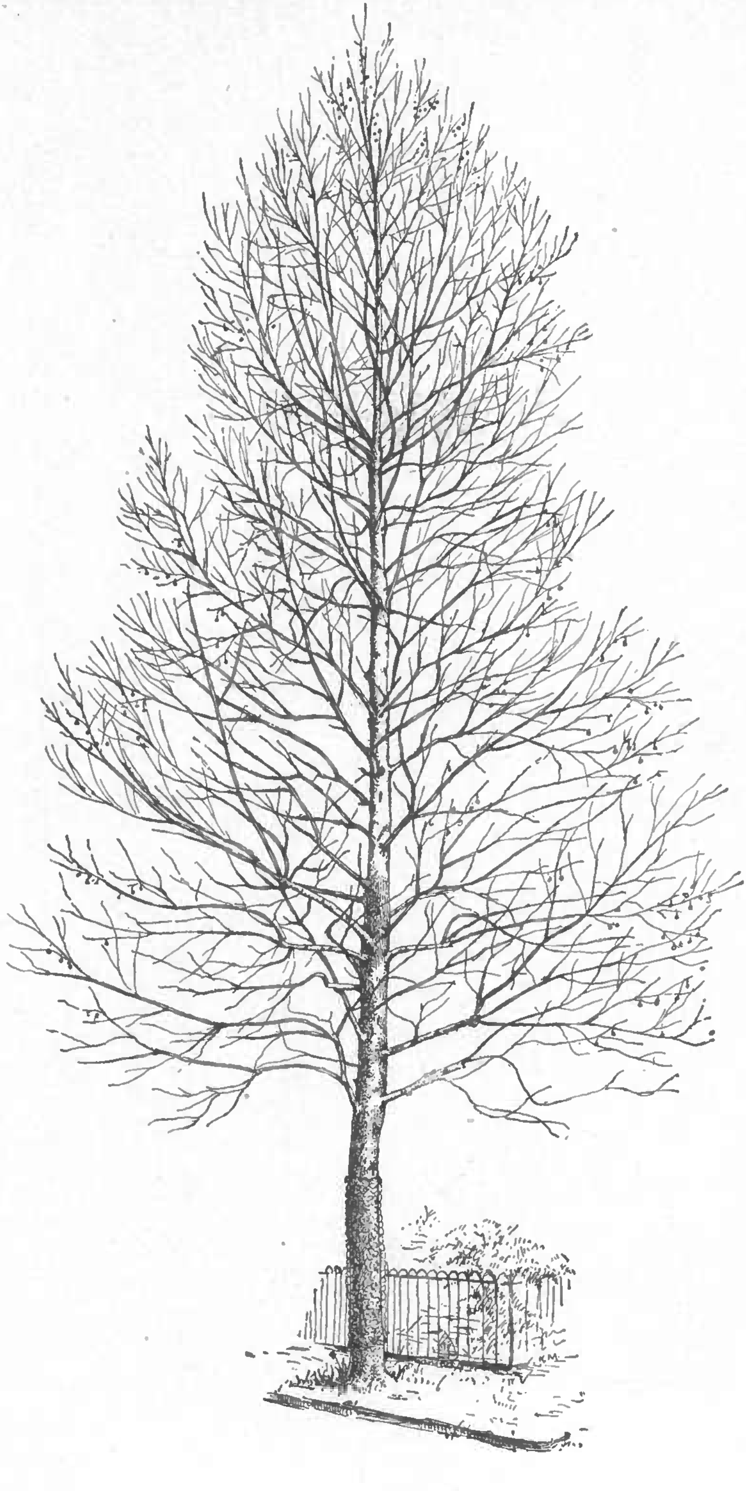


PLATE V.

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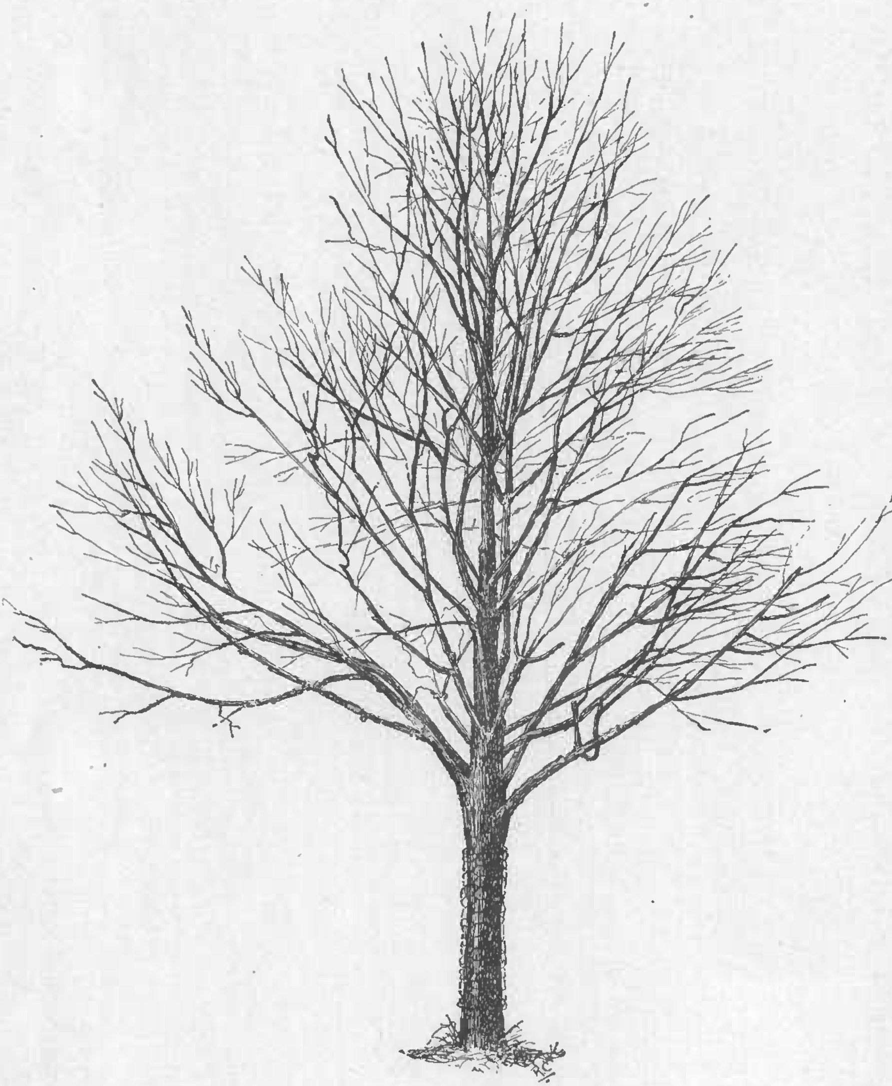

REPORT OF THE CHIEF OF THE DIVISION OF ILLUSTRATIONS.

SIR: I have the honor to submit herewith my second annual report concerning the work of the Division of Illustrations.

Very respectfully,

GEORGE MARX,
Chief.

HON. J. M. RUSK,
Secretary.

The scope of this division has been considerably enlarged during the last year. Besides the supervision of the regular work of the division in preparing all kinds of illustrations for the different divisions of the Department, you have also intrusted me with the custody of all original engravings and electroplates of this Department so far as they have been preserved by the Government Printing Office, and the Public Printer has courteously turned them over to my charge according to your suggestion. An extra room has been fitted up for the safe-keeping of this valuable collection, which has cost the Government many thousands of dollars. These plates still retain their value, and I can now with great facility fill orders for supplying electrotype copies of such illustrations when applied for by the various scientific writers, experimental stations, as well as the agricultural periodicals throughout the country, upon their paying the actual cost of these duplicate plates and under the condition that the Department be credited with furnishing the illustration. A register has been made, and every electro and plate has been duly numbered, catalogued, and recorded. This work has considerably increased the labor and responsibility of the division.

The suggestion made in my last report to extend my personal supervision over the different methods by which illustrations are reproduced, both in lithography and photo processes, having been approved by you, I accordingly spent my summer vacation inspecting the leading establishments in the East as well as the West, in which illustrations are reproduced in colors, in black and white, and by the various graphic processes. The information acquired through the investigation of the more recent methods of reproduction will be of great benefit in the direction of the general improvement of the character of our illustrations.

It has also commended itself to your judgment to charge me with the duty of inspecting the final printing of those plates of approved proofs which are to accompany the publications of the Department, so that any difference existing between the accepted proof and the final prints may be detected and remedied before it is too late.

The character of the work of my division is the same as heretofore, and the entire force has been kept busy in preparing illustrations for

the various divisions of the Department. Another draftsman has been added to my force, and the division now employs eight skilled artists. The rooms have been made more convenient by the addition of several windows, thus securing more light and better ventilation; a messenger has been added to the force, and telephonic connections made with the lower floors.

The correspondence of the division, copying, filing of letters and proofs, cataloguing and account-keeping has assumed such proportions that I have been under the necessity of detailing the assistant wood-engraver for this clerical work, and I respectfully suggest that a clerk be placed at my disposal.

I beg leave to present herewith a short description of the intrinsic work of my division.

The artist who has been educated in the schools or academies of fine arts in this or foreign countries can not in the first instance be of great assistance on our work, as the purpose of his education has been principally to attain artistic effect, while our first requirement is accuracy in the most minute details, the effect being of secondary consideration; at the same time my assistants are required to combine both whenever possible. This holds good especially in the drawings and paintings for the Pomological and Botanical Divisions. The latter furnishes its specimens, in a dried state, from the herbarium, where they have been pressed flat and the natural position of the leaves and flowers consequently greatly changed. It requires, therefore, on the part of the draftsman not only artistic ability, but a botanical knowledge of plants to make a successful life-like illustration from these specimens.

Nor does the result of the work of the artists in this division indicate the amount of preliminary manipulation necessary before the subject is in a suitable condition to be drawn, particularly in the case of illustrations for the Bureau of Animal Industry and the Division of Vegetable Pathology. Here the preliminary arrangements are often a greater task than the actual execution of the illustration.

In microscopical sections, when the character of the tissue is to be represented, as in bacterial diseases, etc., the subject is often so indistinct in its aspects that it sometimes requires days of study and manipulation to bring to a clear view the form or structure of a small organism, and the final result, when it reaches the reader's eye, presents perhaps only a simple spherical or oval line, and the appearance of the drawing does not indicate how much patient study and time have been required to attain this apparently simple result.

The illustrations which accompany the reports on the various diseases of animals are sometimes very trying, and demand a high order of ability as well as endurance on the part of the artist, and it is often a severe test of his faculties when the object is the internal part of a diseased animal, such as a lung, spleen, or intestine in a state of more or less decomposition, which he must closely inspect with a strong magnifying lens in order to examine the subject in minutest detail.

Frequently the subject is in a dried condition, so that it must be boiled in water or soaked in a special preparation, and then "teased out" by fine needles under a dissecting microscope. Many times these efforts prove fruitless, and the patience of the artist is taxed to the utmost before satisfactory results are attained.

During the ripening season of small fruits, such as berries, plums, and apricots, the Department receives in great quantities new and interesting species and varieties for study, which have to be illustrated at once. At such times the whole available force of the division has to be de-

tailed to this work to complete the illustrations of perishable specimens before it is too late, and often the time of the regular working hours is exceeded for this purpose. This will show how great a versatility of talent is needed in our artists. Engaged yesterday in making maps and charts, they are set at work for the Entomologist to-day, and may perhaps be charged with work of an entirely different nature to-morrow.

What has been said in regard to the assistant draftsmen holds equally good in the other branch of my division—wood-engraving.

Illustrations for scientific work by engraving on wood is one of the most perfect methods of reproduction, especially where a great number of impressions are required, as in the case of the Department's annual reports. Texture can by this means be more clearly defined and the strength of light and shade be brought out more successfully than by any other, at the same time preserving the accuracy of the drawing.

The present force of the division (two engravers and one assistant) is entirely inadequate to achieve great results, or even to meet the demand for work of this character, the subjects under consideration requiring great skill and experience as well as considerable time; and while I would like to see the greater part of the drawings reproduced by this process, the small number of engravers employed permits its use only in a limited way. Therefore I would respectfully suggest that the number of wood-engravers be increased to four.

These few instances of the work assigned to this division will serve to give some idea of the time and pains required to become an efficient worker.

REPORT OF THE CHIEF OF THE DIVISION OF RECORDS AND EDITING.

SIR: I have the honor to present herewith a report upon the work of this division for the year 1891.

Very respectfully,

GEO. WM. HILL,
Chief.

Hon. J. M. RUSK,
Secretary.

The general plan of work which was outlined in my last annual report, and which you were good enough to approve, has been followed in this division throughout the year, and, in the light of increased experience, as I have reason to believe, has been found generally satisfactory both to the chiefs of the other divisions, whose published work passes through our hands, and to the Public Printer and his assistants. It should be clear to every one who will take the pains to look over the list of publications of the Department which is appended to this report that the policy of placing some one person in general charge of the publication work, and of focusing, as it were, at some one point all the matter submitted to the head of the Department for publication, preparatory to its transmittal to the Public Printer, is the correct one.

The appropriation for printing for the Department has been, I am glad to say, more liberal than in past years. For the fiscal year ending June 30, 1891, the total amount appropriated for printing for this Department was $47,000, a sum which was found to be utterly inadequate, in view of the increased number of divisions in the Department and of the large number of persons applying to the Department for information which could be given only through some one or other of its bulletins. With the transfer of the Weather Bureau to this Department a special appropriation of $10,000 for the printing expenses of that Bureau was added to the total appropriation for printing and binding for the use of the Department, which thus aggregates for the current fiscal year $75,000.

The policy outlined by yourself in your first annual report in regard to the annual reports of this Department has been closely followed, with the result that, notwithstanding the vast increase in the number of divisions represented therein, the Report for 1890 consisted of but 612 pages as against 708 for the Report of 1888, although in the former were included reports from nineteen divisions, besides a special report from the Assistant Secretary, as against twelve divisions included in the volume for 1888. With the addition of the report of the Weather Bureau, to be included in the Annual Report for 1891, the volume will necessarily be slightly enlarged this year, but is not likely, nevertheless,

to exceed in size the Report for 1888. These facts point to the conclusion that by the policy thus established in regard to this report a sum two or three times larger than the entire cost of the Division of Records and Editing has been annually saved.

The general work of the division is sufficiently indicated by the list of publications already referred to; and after reference to this list it will be very generally admitted by those who have had experience in publication work that the printing fund of the Department has been economically administered in order to realize the amount of work accomplished. The tendency to differentiation in the character of the reports issued, to which special attention was directed in my last report, has been emphasized by the work of the past year, with the result, as it seems to me, that the desirability of a periodical bulletin for the timely record of the current scientific work of the Department in its several divisions appears more strongly than ever. There are certain difficulties in regard to the editing of a bulletin of this character, but none, in my opinion, which may not be satisfactorily overcome. The necessity of presenting to agricultural scientists and to students of scientific agriculture throughout the country a continuous record of the work of scientific agricultural investigation carried on by the several divisions of this Department appears so obvious that no argument seems needed to justify this undertaking.

Advance notices of forthcoming bulletins have been furnished to the press as heretofore, and with the same satisfactory results, the chief of which are that the distribution of the bulletins may begin immediately upon their receipt, and that distribution is insured to those who, as readers of the agricultural papers, are sufficiently interested to apply for this or that particular bulletin, and would thus seem to be the persons most likely to make good use of the information it contains.

The issuing of farmers' bulletins brief in form, of an inexpensive character, and summarizing in plain language the information possessed by the Department in regard to some specific subject of interest to the practical farmer, has been pursued to a limited extent, and in every case has furnished ample evidence of the utility of this style of bulletin. Its availability to reach a very much larger number of individuals than is possible by any other means, moreover, emphasizes the necessity for increasing the number of bulletins of this character. There are believed to be few divisions in the Department which during the year are not in possession of facts obtained in the progress of their work which, because of their practical value, should be promptly communicated to farmers in some section of the country. Owing to their simple form and their brevity, these bulletins can be issued very promptly, and can be speedily distributed, however large their edition. At this writing several bulletins of this character are in course of preparation. The greatly increased demand for the publications of the Department during the past few years has, indeed, made this class of bulletins an absolute necessity, it being impossible, even with an increased printing fund, to furnish the larger and more expensive bulletins in any very great number, even were it always desirable to give them a wide and popular distribution.

The question of reaching the number of persons who are anxious to obtain the publications of the Department is growing constantly more difficult. The number of applicants is yearly increasing, and increasing very rapidly, and all who are practically interested in agriculture have an equal right to participate in the benefits of these publications. It will soon be an impossibility, however, without an increase in the printing fund transcending all reasonable expectations, to satisfy all

applicants. One of the means by which this difficulty might possibly be met, in part at least, would be to fix a very moderate, almost nominal, price upon all the publications of the Department, extending purely gratuitous distribution only to libraries, associations established for the benefit of agriculture, and to those persons who by services rendered to the Department earn their right to its publications. Such a course would at least have the effect of confining the issue of publications to people who need them, and would exclude the large class of applicants who ask for a publication either through idle curiosity, or inspired by the desire, prevalent among some people, to become possessed of anything which they can obtain for nothing. I am strongly of the opinion that some such course as this will ere long become necessary.

During the course of last year the chairman of the Joint Committee on Printing of both Houses of Congress addressed a letter to yourself containing a number of inquiries in regard to the printing and publication work of this Department. These inquiries were answered categorically, and it was gratifying to be able to point out in reply to some of them that the suggestions which they contained in the direction of economy and efficiency in document distribution had already been considered, and efforts made, with some degree of success, toward carrying them out. I may be permitted to say, however, in connection with this subject, that the information regarding the publications of this Department which could be conveyed by replies to a general series of inquiries directed to all the departments of the Government alike could hardly present the subject fairly, so far as the interests of this Department are concerned, to the committee in question, and it is a matter of regret that the committee could not have visited the Department in order to conduct in person an investigation into the character of our publications and the manner of their distribution. I wish to emphasize here the fact, which many people perhaps do not sufficiently appreciate, that in this Department the work of publication is made by law as essential a part of its duty as the work of investigation, the act creating the Department laying as much emphasis upon its duty to diffuse information as upon its duty to acquire it. This, I believe, is not the case with reference to any other of the executive departments of the Government, whose publications are intended chiefly for the information of Congress, while ours are designed especially for the information of a class of our citizens aggregating millions in number.

PUBLICATIONS OF THE YEAR.

To explain the Department's inability to comply with a large number of requests which would seem to have been addressed to it with entire propriety, it should be stated with reference to certain publications mentioned in the following list that, while the number of copies actually issued is believed to be correctly given in each case, these figures do not represent necessarily the number of copies which have been at the disposal of the Department for distribution to applicants. In the case of the Report of the Secretary of Agriculture only one-sixteenth of the edition is available for the use of the Department, the remainder being reserved by law for the use of members of the Senate and House of Representatives. Of the Special Report on Diseases of the Horse, nine-tenths of the Congressional edition of 100,000 copies were thus reserved, the remaining 10,000, together with two editions of 20,000 each, the cost of which was defrayed from Department funds, compris-

ing all which could be furnished in response to the large number of applications directed naturally to the Department in which the work originated. Such special reports, furthermore, as from time to time the Secretary of Agriculture is directed by law to make to Congress are not printed for the use of this Department unless paid for from its own meager fund for printing and binding. Senate Executive Documents Nos. 53 and 222, prepared in the Office of Irrigation Inquiry, belong to this class of publications, and were therefore issued necessarily in very small editions.

Though somewhat at variance with the methods of bibliographers, and in some cases at the risk of needless repetition, certain features of the list of publications which was given in my last annual report have been retained, because of the extent to which they are found to remove a common source of delay and annoyance. Grasses of the Southwest, for example, a publication of the Division of Botany, is mentioned as Botanical Bulletin No. 12, though not bearing upon its title-page exactly this designation. Under the heading Division of Botany it would seem sufficient, and would certainly be correct, to use the term "Bulletin No. 12" alone; but experience has shown that many applicants will overlook the heading and without mentioning the proper division will apply simply for Bulletin No. 12, necessitating correspondence in order to find which one is desired of the several bulletins bearing this number. In this connection, I desire to add that every effort is being made in this division to prevent further complication of the system of numbering bulletins now in use in this Department, and that the desirability of adopting a single series of consecutive numbers for all of our bulletins is clearly recognized. As in last year's report, also, the character of each publication is briefly indicated if not made sufficiently clear by the title alone, and no mention is made of printed matter which may properly be classed as correspondence. Regarding the so-called "Authors' editions" it should be stated that they are largely intended to promote economy in the distribution of the Annual Report, being usually mailed in cases where reports from other divisions are not required. The size of each publication is octavo unless otherwise specified.

OFFICE OF THE SECRETARY.

	Copies.
Report of the Secretary of Agriculture for 1890. Pp. 612, illustrated. April, 1891	400,000
Report of the Secretary of Agriculture for 1891. (Preliminary.) Pp. 59. November, 1891	30,000
Report on the Use of Maize (Indian Corn) in Europe. Pp. 36. December, 1891	10,000
Special Report of the Assistant Secretary—The Scientific Work of the Department in its Relations to Practical Agriculture. (From the Report of the Secretary of Agriculture for 1890.) Pp. 59–76. April, 1891	1,000

BUREAU OF ANIMAL INDUSTRY.

The Animal Parasites of Sheep. Pp. 222, pl. 32. (Reprint.)	5,000
Special Report on Diseases of the Horse. Pp. 560, pl. 44. February, 1891	140,000
Special Report on the Cause and Prevention of Swine Plague. Pp. 166, pl. 12. September, 1891	5,000
Report of the Chief of the Bureau of Animal Industry for 1890. Author's edition. (From the Report of the Secretary of Agriculture for 1890.) Pp. 75–132. May, 1890	500

DIVISION OF BOTANY.

Botanical Bulletin No. 12, Part II. Grasses of the Southwest. Plates and Descriptions (50) of the Grasses of the Desert Region of Western Texas, New Mexico, Arizona, and Southern California. Size, 7½ by 11½ inches. December, 1891	5,000

	Copies.
Botanical Bulletin No. 14. Ilex Cassine, the Aboriginal North American Tea—Its History, Distribution, and Use among the North American Indians. Pp. 22, illustrated. November, 1891	2,000
Contributions from the U. S. National Herbarium. Vol. 2, No. 1. Manual of the Phanerogams and Pteridophytes of Western Texas. Pp. 152, with one illustration. June, 1891	2,500
Contributions from the U. S. National Herbarium. Vol. 1, No. 4. List of Plants Collected by Dr. Edward Palmer, in 1890, in Western Mexico and Arizona. Pp. 91-128, pl. 10. July, 1891	2,500
Report of the Botanist for 1890. Author's edition. (From the Report of the Secretary of Agriculture for 1890.) Pp. 375-392, pl. 8. May, 1891	500

DIVISION OF CHEMISTRY.

Chemical Bulletin No. 28. Proceedings of the Seventh Annual Convention of the Association of Official Agricultural Chemists, held at the U. S. National Museum, August 28, 29, and 30, 1890. Methods of Analysis of Commercial Fertilizers, Foods, and Feeding Stuffs, Dairy Products, Fermented Liquors, and Sugars. Pp. 238, illustrated. March, 1891	2,500
Chemical Bulletin No. 29. Record of Experiments with Sorghum in 1890. Pp. 126. May, 1891	10,000
Chemical Bulletin No. 30. Experiments with Sugar Beets in 1890. Pp. 94. May, 1891	10,000
Farmers' Bulletin No. 3. Culture of the Sugar Beet. Pp. 24, illustrated. March, 1891	50,000
Chemical Bulletin No. 13, Part 2. Foods and Food Adulterants—Spices and Condiments. Pp. 129-260, pl. 16. (Reprint)	1,000
Chemical Bulletin No. 13, Part 3. Foods and Food Adulterants—Fermented Alcoholic Beverages, Malt Liquors, Wine, and Cider. Pp. 261-400, illustrated. (Reprint.)	1,000
Report of the Chief of the Division of Chemistry for 1890. Authors' edition. (From the Report of the Secretary of Agriculture for 1890.) Pp. 133-192. May, 1891	500

DIVISION OF ENTOMOLOGY.

Entomological Bulletin No. 6. (Second edition.) The Imported Elm Leaf-beetle: its Habits and Natural History, and Means of Counteracting its Injuries. Pp. 22, illustrated. December, 1891	2,500
Entomological Bulletin No. 7. The Pediculi and Mallophaga Affecting Man and the Lower Animals. Pp. 56, illustrated. April, 1891	2,000
Entomological Bulletin No. 23. Reports of Observations and Experiments in the Practical Work of the Division. Pp. 84. May, 1891	5,000
Entomological Bulletin No. 24. The Boll Worm of Cotton: A Report of Progress in a Supplementary Investigation of this Insect. Pp. 50, illustrated. May, 1891	5,000
Entomological Bulletin No. 25. Destructive Locusts: A Popular Consideration of a Few of the More Injurious Locusts (or Grasshoppers) of the United States, together with the Best Means of Destroying Them. Pp. 62, with map, figures, and 12 plates. June, 1891	5,000
Insect Life. (Devoted to the economy and life-habits of insects, especially in their relations to agriculture, and edited by the Entomologist and his assistants. With illustrations.)	
Vol. 3, No. 5. Pp. 179-250. January, 1891	5,000
Vol. 3, No. 6. Pp. 251-304. April, 1891	5,000
Vol. 3, Nos. 7 and 8. Pp. 305-358. May, 1891	5,000
Vol. 3, Nos. 9 and 10. Pp. 359-432. June, 1891	5,000
Vol. 3, Nos. 11 and 12. Pp. 433-519, with index of volume. September, 1891	5,000
Vol. 4, Nos. 1 and 2. Pp. 86. October, 1891	5,250
Vol. 4, Nos. 3 and 4. Pp. 87-162. December, 1891	5,000
Entomological Circular No. 1, second series. Condensed Information Concerning Some of the more Important Insecticides. Pp. 7. May, 1891	1,000
Entomological Circular No. 2, second series. The Hop Plant-louse and the Remedies to be Used Against It. Pp. 7, illustrated. June, 1891	15,000
Report of the Entomologist for 1890. Author's edition. (From the Report of the Secretary of Agriculture for 1890.) Pp. 237-264. May, 1891	500

OFFICE OF EXPERIMENT STATIONS.

	Copies.
Experiment Station Bulletin No. 2, Part 2. Digest of the Annual Reports of the Agricultural Experiment Stations in the United States for 1888. Pp. 173. July, 1891	5,000
Miscellaneous Bulletin No. 3. Proceedings of the Fourth Annual Convention of the Association of American Agricultural Colleges and Experiment Stations held at Champaign, Ill., November 11, 12, and 13, 1890. Pp. 156. August, 1891	4,000
Experiment Station Record. (A condensed record of the contents of the bulletins issued by the Agricultural Experiment Stations of the United States).	
Vol. 2, No. 6. Pp. 265–308. January, 1891	5,000
Vol. 2, No. 7. Pp. 309–384. February, 1891	5,000
Vol. 2, No. 8. Pp. 385–468. March, 1891	7,000
Vol. 2, No. 9. Pp. 469–540. April, 1891	5,000
Vol. 2, No. 10. Pp. 541–624. May, 1891	5,000
Vol. 2, No. 11. Pp. 625–698. June, 1891	5,000
Vol. 2, No. 12. Pp. 699–853, with index of volume. July, 1891	5,000
Vol. 3, No. 1. Pp. 72. August, 1891	5,200
Vol. 3, No. 2. Pp. 73–138. September, 1891	5,000
Vol. 3, No. 3. Pp. 139–206. October, 1891	5,000
Vol. 3, No. 4. Pp. 207–274. November, 1891	5,200
Vol. 3, No. 5. Pp. 275–364. December, 1891	5,200
Circular No. 18 of the Office of Experiment Stations. List of Originators of Fruits and Vegetables in the United States, with Addresses and Names of Specialties. Pp. 12. March, 1891	1,250
Circular No. 19 of the Office of Experiment Stations. (Circular letter relative to coöperation in experiments with fertilizers on fruits and vegetables, to study the feeding capacities of the plants and the variations due to the action of fertilizers.) Pp. 4. March, 1891	700
Circular No. 20 of the Office of Experiment Stations. Organization List of the Agricultural Experiment Stations in the United States. Pp. 21. June, 1891	2,000
Circular No. 21 of the Office of Experiment Stations. (List of the representatives of Agricultural Colleges and Experiment Stations who were in attendance upon the Fifth Annual Convention of the Association of American Agricultural Colleges and Experiment Stations. Printed for the use of the Convention.) Pp. 4. August, 1891	200
Circular No. 22 of the Office of Experiment Stations. (Relative to subject index of the literature of agricultural experiment stations and kindred institutions.) Pp. 4. November, 1891	600
Report of the Director of the Office of Experiment Stations for 1890. Author's edition. (From the Report of the Secretary of Agriculture for 1890.) Pp. 489–555. May, 1891	500

OFFICE OF FIBER INVESTIGATIONS.

Fiber Report No. 2. Recent Facts Regarding the Ramie Industry in America, with Brief Statements Relating to Manufacture in Europe, etc. Pp. 16. May, 1891. (Reprinted from Statistical Report No. 84.)	1,000
Fiber Report No. 3. A Report on Sisal Hemp Culture in the United States, with Statements Relating to the Industry in Yucatan and the Bahama Islands, and Brief Considerations upon the Question of Machinery for Extracting the Fiber. Pp. 59, cuts 21, pl. 8. July, 1891	5,000
Report of the Special Agent in Charge of Fiber Investigations. Author's edition. (From the Report of the Secretary of Agriculture for 1890.) Pp. 451–470. April, 1891	500

DIVISION OF FORESTRY.

Forestry Bulletin No. 4. Report on the Substitution of Metal for Wood in Railroad Ties, together with a Discussion on Practicable Economies in the Use of Wood for Railway Purposes. Pp. 363, pl. 30. (Reprint)	1,000
Forestry Bulletin No. 5. What is Forestry? Pp. 52. July, 1891	25,000
Circular No. 6 of the Division of Forestry. (Circular letter to accompany tree seeds distributed from the Department of Agriculture, and furnishing necessary instructions for growing tree seedlings.) Pp. 4, letter size. April, 1891	3,000

	Copies.
Circular No. 7 of the Division of Forestry. (Circular of information regarding the Government timber tests undertaken by the Division of Forestry.) Pp. 4. September, 1891	1,000
Report of the Chief of the Division of Forestry for 1890. Author's edition. (From the Report of the Secretary of Agriculture for 1890.) Pp. 193-236. May, 1891	500

DIVISION OF GARDENS AND GROUNDS.

Papers on Horticultural and Kindred Subjects. (Reprinted from various annual reports of the Department of Agriculture.) Pp. 124. July, 1891	5,000
Catalogue of Economic Plants in the Collection of the United States Department of Agriculture. (Reprinted from the Report of the Secretary of Agriculture for 1890.) Pp. 42. July, 1891	15,000
Report of the Chief of the Division of Gardens and Grounds for 1890. Author's edition. (From the Report of the Secretary of Agriculture for 1890.) Pp. 557-596. May, 1891	500

OFFICE OF IRRIGATION INQUIRY.

Senate Executive Document No. 53, Part 1. Progress Report on Irrigation in the United States. Pp. 337, with maps, plats, and profiles. April, 1891	1,500
Senate Executive Document No. 53, Part 2. Progress Report of Artesian and Underflow Investigation between the Ninety-seventh Degree of West Longitude and the Foothills of the Rocky Mountains, with map and profiles. Pp. 14; appendices 10. May, 1891	1,500
Senate Executive Document No. 222. Report on the Preliminary Investigation to Determine the Proper Location of Artesian Wells within the Area of the Ninety-seventh Meridian and East of the Foothills of the Rocky Mountains. Pp. 398, with illustrations and maps. January, 1891	100
Report of the Special Agent in Charge of the Artesian and Underflow Investigations and of the Irrigation Inquiry, 1890. Author's edition. (From the Report of the Secretary of Agriculture for 1890.) Pp. 471-488, with map. May, 1891	500

DIVISION OF MICROSCOPY.

Report of the Microscopist for 1890. Author's edition. (From the Report of the Secretary of Agriculture for 1890.) Pp. 361-374, pl. 11. May, 1890	500
Food Products. No. 2. Eight Edible and Twelve Poisonous Mushrooms of the United States, with Directions for the Culture and Culinary Preparation of the Edible Species. (A reprint of "Mushrooms of the United States," from the Annual Report of the Secretary of Agriculture for 1890, pp. 365-374, with a brief appendix: List of the Edible Fungi of the United States.) Pp. 16, pl. 5. October, 1891	3,000

DIVISION OF ORNITHOLOGY AND MAMMALOGY.

North American Fauna No. 5. (A record of the results of a biological reconnoissance of south-central Idaho, with annotated lists of the mammals and birds, and descriptions of new species.) Pp. 132, pl. 4. August, 1891	5,000
Report of the Ornithologist and Mammalogist for 1890. Author's edition. (From the Report of the Secretary of Agriculture for 1890.) Pp. 277-285. May, 1891	500

DIVISION OF POMOLOGY.

Pomological Bulletin No. 1. Report on the Condition of Tropical and Semitropical Fruits in the United States in 1887. Pp. 149. (Reprint, without plates of first edition.)	2,000
Pomological Bulletin No. 4. Report on the Relative Merit of Various Stocks for the Orange, with notes on Mal di Goma and the Mutual Influence of Stock and Scion. Pp. 21. May, 1891	2,500
Pomological Circular No. 3. (Circular of inquiry relative to apple culture. Reprint.) Pp. 4, letter size	6,000
Pomological Circular No. 7. (Circular of inquiry relative to peach culture.) Pp. 4, size 8 by 13 inches. March, 1891	6,500
Report of the Pomologist for 1890. Author's edition. (From the Report of the Secretary of Agriculture for 1890.) Pp. 409-424, pl. 9. May, 1891	500

DIVISION OF RECORDS AND EDITING.

Copies.

Report of the Chief of the Division of Records and Editing. Author's edition. (From the Report of the Secretary of Agriculture for 1890.) Pp. 437-447. May, 1891 500

SILK SECTION.

(Discontinued June 30, 1891.)

Report of the Chief of the Silk Section for 1890. Author's edition. (From the Report of the Secretary of Agriculture for 1890.) Pp. 265-276. May, 1891 500

DIVISION OF STATISTICS.

Statistical Report No. 81. Report upon the Numbers and Values of Farm Animals, and on Freight Rates of Transportation Companies. (With European Crop Report for February, Notes on Foreign Agriculture, and Reports on the Cotton Crop for 1890, the Canning Industry in 1890, the Angora Goat in California, and New Railroad Construction in 1890.) Pp. 56. February, 1891 18,000

Statistical Report No. 82. Report on Distribution and Consumption of Corn and Wheat, and on Freight Rates of Transportation Companies. (With European Crop Report for March, and articles on Agricultural Contributions to International Commerce, and Legal Weights per Bushel.) Pp. 57-104. March, 1891 18,000

Statistical Report No. 83. Report of the Condition of Winter Grain, the Condition of Farm Animals, and on Freight Rates of Transportation Companies. (With European Crop Report for April, and articles on the Permanency of Agricultural Production and Rural Coöperative Banks in Russia.) Pp. 105-158. April, 1891 18,000

Statistical Report No. 84. Report on the Condition of Winter Grain, the Progress of Cotton Planting; also on the Freight Rates of Transportation Companies. (With European Crop Report for May, Notes on Foreign Agriculture, and articles on Better Times for Farmers, Recent Facts regarding Ramie, and Agriculture in Brazil.) Pp. 159-238. May, 1891 .. 18,000

Statistical Report No. 85. Report on the Acreage of Wheat and Cotton, and Condition of Cereal Crops, and on Freight Rates of Transportation Companies. (With European Crop Report for June, Official Statistics of Foreign Crops, and Report on the Agriculture of Chile.) Pp. 239-302. June, 1891 18,000

Statistical Report No. 86. Report on the Area of Corn, Potatoes, and Tobacco, and Condition of Growing Crops, and on Freight Rates of Transportation Companies. (With European Crop Report for July, and articles on European Rye Production, the Coöperative Credit Unions or People's Banks of Germany, and Agriculture in Peru.) Pp. 303-374. July, 1891.. 18,000

Statistical Report No. 87. Report on the Condition of Growing Crops, and on Freight Rates of Transportation Companies. (With European Crop Report for August, and articles on the Indian Wheat Crop of 1891, and on the Raffeisen Loan Association of Germany.) Pp. 375-438. August, 1891.. 18,000

Statistical Report No. 88. Report on Condition of Crops in America and Europe, and on Freight Rates of Transportation Companies. (With articles on Official Returns of Russian Cereals, the Rye Situation, the Low Price of Cotton, Prices Seventy Years Ago, Crops in Indiana and Illinois, and Agriculture in Ecuador, and Notes on Foreign Agriculture.) Pp. 439-518. September, 1891 18,000

Statistical Report No. 89. Report on Condition of Crops, Yield of Grain per Acre, and of Freight Rates of Transportation Companies. (With European Crop Report for October, a Compilation of Foreign Tariffs on Agricultural Products, and Reports on the Wine Industry of Napa County, Cal., and on Agriculture in Bolivia and in Japan.) Pp. 519-590. October, 1891 19,000

Statistical Report No. 90. Report on Yield of Crops per Acre, and on Freight Rates of Transportation Companies. (With European Crop Report for November, Notes on Foreign Agriculture, and a Report on Agriculture in Paraguay.) Pp. 591-634. November, 1891 19,000

Statistical Report No. 91. Report on the Crops of the Year, and on Freight Rates of Transportation Companies. (With European Crop Report for December, and articles on Farm Prices, Distribution of Spring and Winter Wheat, Cotton Imports of the United States, the Canning Industry, and Agriculture in Uruguay and in the Guianas.) Pp. 635-698. December, 1891. 19,000

	Copies.
Album of Agricultural Graphics. Values per Acre of Crops of the United States, based on Results of Official Statistical Investigation. (Ten colored maps illustrating by States the values and yields per acre of corn, wheat, oats, rye, barley, buckwheat, potatoes, tobacco, cotton, and hay, with brief introductory text.) Size 12½ by 18½ inches. March, 1891	20,000
Album of Agricultural Statistics of the United States. Results of Official Statistical Investigation. (Sixteen colored charts relating to farm areas, acreage and yield of corn, wheat, and oats, average value of farm animals and of lands, rural population, and farm tenures.) Size 9½ by 12½ inches. (Reprint)	15,000
Monthly Synopses, condensed from the regular statistical reports for prompt and wide circulation in advance of the same, the issue of each month being numbered to correspond with the report upon which it is based:	
Crop Synopsis No. 81. Pp. 4. February, 1891	78,000
Crop Synopsis No. 82. Pp. 4. March, 1891	78,000
Crop Synopsis No. 83. Pp. 4. April, 1891	78,000
Crop Synopsis No. 84. Pp. 4. May, 1891	78,000
Crop Synopsis No. 85. Pp. 4. June, 1891	78,000
Crop Synopsis No. 86. Pp. 4. July, 1891	116,000
Crop Synopsis No. 87. Pp. 4. August, 1891	120,000
Crop Synopsis No. 88. Pp. 4. September, 1891	122,000
Crop Synopsis No. 89. Pp. 4. October, 1891	122,000
Crop Synopsis No. 90. Pp. 4. November, 1891	122,000
Crop Synopsis No. 91. Pp. 4. December, 1891	122,000
Report of the Statistician for 1890. (From the Report of the Secretary of Agriculture for 1890). Pp. 287-360; statistical maps, 3. May, 1891	500

DIVISION OF VEGETABLE PATHOLOGY.

Bulletin No. 1 of Division of Vegetable Pathology. Additional Evidence on the Communicability of Peach Yellows and Peach Rosette. Pp. 65, pl. 38. December, 1891	5,000
Journal of Mycology. (Devoted to the study of fungi, especially in their relation to plant diseases. With illustrations.)	
Vol. 6, No. 3. Pp. 89–136. January, 1891	2,500
Vol. 6, No. 4. Pp. 137–207, with index of volume. May, 1891	2,500
Vol. 7, No. 1. Pp. 64. September, 1891	2,500
Farmers' Bulletin No. 4. Fungous Diseases of the Grape and their Treatment. Pp. 12. March, 1891	15,000
Circular No. 10 of the Division of Vegetable Pathology. Treatment of Nursery Stock for Leaf-blight and Powdery Mildew. Pp. 8, cuts 3. April, 1891	5,000
Circular No. 11 of the Division of Vegetable Pathology. (Letter of inquiry regarding losses from grape diseases and the extent to which fungicides are employed.) Half sheet, 8½ by 14 inches. December, 1891	1,000
Circular No. 12 of the Division of Vegetable Pathology. (Letter of inquiry relative to the rust of wheat, oats, rye, and barley.) Half sheet, 8½ by 14 inches. December, 1891	4,000
Report of the Chief of the Division of Vegetable Pathology for 1890. (From the Report of the Secretary of Agriculture for 1890.) Author's edition. Pp. 393–408, pl. 5. May, 1891	500

WEATHER BUREAU.

(July 1 to December 31, 1891.)

Special Report of the Chief of the Weather Bureau. (Summary of the operations of the Bureau during the three months immediately following its transfer to the Department of Agriculture, with an account of the objects and methods of its work.) Pp. 26. October, 1891	25,000
Monthly Weather Review. (A monthly summary of the weather conditions observed throughout the United States and reported by Weather Bureau agents, State weather services, and others.)	
Vol. XIX, No. 5, May, 1891	3,000
Vol. XIX, No. 6, June, 1891	3,000
Vol. XIX, No. 7, July, 1891	3,000
Vol. XIX, No. 8, August, 1891	3,000
Vol. XIX, No. 9, September, 1891	3,000
Vol. XIX, No. 10, October, 1891	3,000

	Copies.
Weather Map. (Issued twice daily, showing weather conditions throughout the United States, and furnishing forecasts of probable changes.) Size, 19 by 24 inches. Average daily issue	590
Weather Crop Bulletin. (A brief summary of the condition of weather and crops of the United States, showing by maps and tables the departures from normal temperature and rainfall for the period covered by the bulletin. Issued weekly from March to October, inclusive, a separate monthly edition being continued throughout the year, and all issues being numbered consecutively in the order of their appearance. Uniform with Weather Map in size and form.) Nos. 22 to 39. Average number of each issue	1,257

REPORT OF THE SUPERINTENDENT OF THE DOCUMENT AND FOLDING ROOM.

SIR: I have the honor to submit herewith my report on the work of the Document and Folding Room during the year 1891.

Very respectfully,

A. T. LONGLEY,
Superintendent.

Hon. J. M. RUSK,
Secretary.

The character of the work of this division does not materially change from year to year, except in so far as it is modified as the result of our efforts to meet the growing demands occasioned by the great increase in the number of publications for distribution. During the present administration this increase has been very marked, and the result has been that the efforts of myself and assistants have been taxed to the utmost in the handling of the enormous quantity of documents received, the keeping of a record of the same and of their distribution, and the folding and distribution of them in a prompt and business-like manner.

What are known as the permanent lists, embracing those parties to whom all the publications of the Department are sent, have been frequently revised with a view to keeping them within reasonable limits. These permanent lists consist chiefly of Senators and Representatives, officers of National and State agricultural associations, libraries, and educational institutions especially devoted to agricultural instruction, agricultural newspapers and other journals publishing agricultural editions, and sundry persons devoting considerable time to agricultural subjects, such as leading stock-growers, horticulturists, etc. In former years the tendency of these lists was to grow very rapidly, but, thanks to the revision which I have spoken of and the care exercised before placing the name of any person or institution on these lists, they have been considerably reduced of late years, but still absorb in the neighborhood of 2,300 copies of every bulletin issued by the Department.

Another subject to which our attention and efforts have been particularly directed is the prevention of duplication. While considerable has been accomplished in this direction, I am free to say that, without some modification of the present system, this object can not be invariably attained. A system of duplicate lists, one of which should be kept in each division of the Department and the other in the Folding Room, as is done in the case of newspapers, and an increase in the force at my disposal in the Folding Room sufficient to enable me to have all franks written under my own supervision, would, I believe, result in insuring absolutely the object sought. An extension of one or the other of the mailing systems in use among newspapers to cover all per-

manent lists, by which the franks could be printed and a mailing-machine used, would effect, I am satisfied, a great saving in the time occupied and cost in the mailing of our documents.

Apart from the great number of franks written in several of the divisions, the number of franks written in the Folding Room for the past year aggregated the enormous number of 642,500, in addition to which there were also addressed and mailed to correspondents supplies aggregating 168,000 letter-sheets and circulars and 336,000 envelopes. Of advance notices prepared for the press in the Division of Records and Editing there were folded and directed in the Folding Room 156,000, while the number of letters and postals written in this division under my direction aggregated nearly 10,000. The importance of concentrating the work of this character in this division is shown by the necessity of avoiding any possible duplication in the distribution of documents, of which, however large the edition published, we rarely have enough to supply the demand, and the necessity for the prompt and business-like performance of these apparently simple and mechanical duties lies in the fact that any mistakes or delays involve additional and useless correspondence, and that our work, dealing almost entirely with persons outside the Department, is naturally regarded by such persons as a criterion of the business-like methods pursued in Department work. It is obvious, indeed, that this division, being the channel for the distribution of publications and documents, representing the vast amount and high quality of the work done in the several branches of the Department, any delay or carelessness in the performance of our work seriously mars the value of the Department work in general.

I emphasize these details here as a justification for the frequent appeals for additional help in the performance of my work, adding merely that, by comparison with the work devolving upon this division but a few years ago, the amount of work accomplished now is at least 50 per cent greater per capita of the force employed than it was then, and I believe that with some of the additional improvements in our methods of keeping lists and in our system of distribution, such as I have suggested, this increase could be carried still further and even greater efficiency attained. I will add that the tendency, already alluded to, of multiplying the number of publications and documents issued by the Department is still on the increase, and that it must be borne in mind not only that every separate publication, however brief it may be, involves almost as much work in its distribution as the more ponderous bulletins, but that, furthermore, many of these brief publications, such as farmers' bulletins, are issued to meet special emergencies, necessitating their distribution with the utmost dispatch.

I have to note with great gratification the fact that better facilities have been provided during the past year for the accommodation of this division and for the proper storing and handling of the large number of publications received. At the same time, I regret to have to call attention to the fact that these accommodations are still inadequate, not only more room being required, so as to store all the publications in our possession in the one building and under the immediate supervision of the chief of the Folding Room, but that the buildings in which, for want of other room, all publications of the Department, aggregating in value a very large sum, are stored, and many of which it would doubtless be impossible to replace in case of loss, are insecure, and in case of fire would afford no protection whatever.

In concluding this report I desire to emphasize once more the utter inadequacy of the number of copies of the Annual Report now furnished

to this Department for its use. The number of division correspondents to whom the Department is under obligations to send the Annual Report, as compensation in a certain sense for services rendered, is so large that we are practically deprived of any copies for miscellaneous and general distribution. We are already practically out of copies of the Annual Report for 1890, and we are already compelled to reply to applicants asking for the forthcoming Report for 1891 that we will be unable to comply with their requests, our quota being practically exhausted as soon as received. In view of the immense number of persons who apply directly to this Department for a copy of the Annual Report, a large amount of work is thrown upon us in writing letters or sending circulars, explaining our inability to comply with these requests, which might be avoided if the number of copies placed at the disposal of the Department was increased in proportion to the increase in the number of divisions which the Department includes; instead of which our quota is now and has been for the past two or three years five thousand less in number than it was several years ago, when the demand upon us was not so great.

REPORT OF THE DIRECTOR OF THE OFFICE OF EXPERIMENT STATIONS.

SIR: I have the honor to present herewith the report of the Office of Experiment Stations for the year 1891. Prof. W. O. Atwater was director of the office up to July 15 of the present year. Although he has resigned the directorship, his services are retained as a general counselor on scientific matters, and he is a regular contributor to the publications of the office. During the year the editorial and clerical force of the office has been somewhat enlarged. To the faithful and efficient service of the entire office force is due in large measure whatever success has attended the labors of the year. The limits of this report only permit of brief statements regarding the work of the office and a few illustrations of the work of the stations, together with some general statistics regarding the stations and the agricultural colleges.

Respectfully,

A. W. HARRIS,
Director.

Hon. J. M. RUSK,
Secretary.

OPERATIONS OF THE OFFICE OF EXPERIMENT STATIONS.

WORK OF THE YEAR.

The principal business of the Office of Experiment Stations during the past year, as heretofore, has been the preparation of publications relating to the work of the agricultural experiment stations. Nineteen documents, aggregating 1,335 pages, have been issued, chief among which is the second volume of the Experiment Station Record, consisting of twelve numbers, with a classified table of contents and a detailed index. The office has, however, given much attention to other matters, some of which will be briefly mentioned in this report.

Correspondence.—The correspondence of the office is still growing. The number of letters received during the year was 7,133. This correspondence includes requests for publications and for information which may be supplied by publications; inquiries in regard to the location, organization, and work of experiment stations in this country; inquiries for general and specific information on a wide range of topics in scientific and practical agriculture; communications from the experiment stations or their officers regarding the scientific, administrative, and general interests of the stations; and an increasing number of inquiries in regard to experimental investigations in foreign countries.

Visiting stations and conventions.—In order that the office may be brought into the intimate relations with the stations which are necessary for the successful prosecution of its work, it is important that its officers visit the stations regularly and with some frequency. This is all the more necessary since the Department is required by law to advise and aid the stations, but has no authority to exercise control over them. The value of personal acquaintance with the station workers and their work has been clearly recognized. Since the last Annual Report was presented, representatives of the office have visited twenty-three stations, and have attended the meetings of the Association of American Agricultural Colleges and Experiment Stations and the Association of Official Agricultural Chemists, at Washington, D. C. The office was also represented at the recent meeting of officers of the German experiment stations at Halle.

Collection of publications.—The current publications of the stations have been carefully collected and catalogued, and efforts have been made to make the office list of the earlier publications more complete. With the undertaking of the abstracting and indexing of reports of investigations in foreign countries, it has of course become necessary to begin the collection of foreign publications. But little has thus far been done except with the more common periodical publications in English and German. For the proper prosecution of work in this line, not only should the list of current periodical publications be enlarged to include those from all the countries in which investigations in agricultural science are in progress, but the office should also obtain such original accounts of inquiries as are not published in journals. The office is at present in the somewhat anomalous position of devoting itself, at considerable cost, to the reviewing of foreign work without the possession of any considerable number of foreign publications. To obtain such a working library as the proper performance of this work demands will involve the annual expenditure for this purpose of a considerable sum beyond the present resources of the office. The office has, however, received quite a number of foreign publications as gifts or exchanges.

It should be understood that such a library of foreign publications as is here contemplated would be for the use not only of this office, but of the stations themselves. It is evident that it is now and must be in the future increasingly difficult for the stations to accumulate libraries which shall in all the lines of their work include not only standard publications, but those which, while necessary at times, will as a rule be used infrequently. It is hoped that it will be possible to build up in the Department a reference library, which shall contain not only those documents which are necessary for the regular work of the office, but those which by their cost or rarity will not be found in the libraries of the stations, or which by reason of the infrequency of their use it would be inexpedient for the stations to purchase. Certainly the Department should possess all the documents on which the indexes and abstracts prepared by this office are based.

Mailing list of the office.—The edition of the Experiment Station Record and other technical publications of the office has been 5,000 copies until within a few months, when it has been found necessary to increase it to 5,200. As the Record is intended primarily for experiment station officers and other workers in agricultural science, it has not been the policy to attempt its wide distribution to farmers. It has, however, been sent to all applicants to whom it seemed likely to be of real service. In order to accomplish a wise and prevent a wasteful distribution,

it has been the invariable practice to send to persons applying for the Record but one copy, accompanied with a form for certification that the sample copy had been examined and found useful. Only after the return of this certificate, with the proper signature and address, is the name of the applicant placed upon the list. Moreover, at intervals it has been customary to send out blank forms for acknowledgment, the return of which is required in order to retain any name upon the list. As a result of these efforts, it is believed that the documents of the office have as a rule been placed in the hands of those who make good use of them. Despite these precautions, the list has been steadily growing.

Mailing lists for the stations.—The office has assisted the stations in the distribution of their publications and saved them considerable expense by furnishing them with printed mailing lists containing the names of the members of the governing boards and working staffs of the various stations. This list is kept standing in type, and is corrected as soon as information of mistakes or changes is received.

Experiment station exhibit at the World's Columbian Exposition in 1893.—As stated in the last Annual Report, plans were drawn up by this office for a collective exhibit of the experiment stations to be made at the World's Columbian Exposition in Chicago. These plans were presented to the convention of the Association of American Agricultural Colleges and Experiment Stations at Champaign, Ill., in November, 1890. They were cordially received, and a committee was appointed to represent the association in conferring with this Department with reference to arrangements for such an exhibit. The committee are Directors Armsby, of Pennsylvania; Morrow, of Illinois; Thorne, of Ohio; Tracy, of Mississippi, and Henry, of Wisconsin. Immediately after the adjournment of the convention, the plans were revised and sent by the committee to the stations for suggestions and adoption. They called out hearty approval from the stations, which undertook to furnish the needed assistance in carrying them out. At a meeting of the committee held in Chicago in the spring of 1891, attended by the present director of this office, plans were perfected and finally adopted, and the preparation of the various parts of the exhibit assigned to specialists. They have entered upon their work with energy.

The plan includes (1) an experiment station in operation, to be manned by station workers, containing an office, library, chemical, botanical, and entomological laboratories, greenhouse, stable, and dairy; (2) an exhibit of the work of the stations, to be made up of two parts; the first containing exhibits of the individual stations, showing location, climatic relations, plans of buildings, history, resources, principal lines of work, etc.; and the second consisting of topical exhibits of the work of the stations, illustrating methods, apparatus, and results pertaining to special subjects or classes of subjects.

Small pamphlets, primers, or leaflets explaining the exhibit are contemplated, and it is proposed that members of the station staffs, students of the agricultural colleges, or others be detailed as demonstrators to explain to visitors the meaning of the exhibit.

It is the purpose to make this exhibit a means of education to farmers and others interested in such topics. The exhibits will be selected with a view to presenting in an attractive and simple form the main facts of the more important lines of agricultural science and investigation.

PUBLICATIONS OF THE OFFICE OF EXPERIMENT STATIONS.

The publications issued or in course of preparation are divided into six classes:

(1) The Experiment Station Record, issued in parts and containing brief abstracts of the current publications of the stations, together with matters of kindred interest.

(2) Experiment station bulletins, intended for station workers and others specially interested in agricultural science.

(3) Farmers' bulletins, containing accounts of experiment station work and cognate information in brief popular form. These are intended for general distribution to farmers and others.

(4) Miscellaneous bulletins, treating of a variety of subjects more or less intimately related to the stations and agricultural colleges.

(5) Monographs on special topics in agricultural science.

(6) Circulars containing matters of transient or restricted importance and usually intended for limited circulation.

A list of the publications for general distribution thus far issued by the office, with their titles, may be found on page 527. The following seem to require special notice:

Experiment Station Record.—The second volume of the Experiment Station Record was completed with the number for July, 1891. This volume of 853 pages contains abstracts of 329 bulletins and 42 annual reports from 53 experiment stations in the United States, and 36 bulletins from the Department of Agriculture. The total number of pages in these publications is 14,791. There were also abstracts of 8 bulletins and 1 annual report from Canada, and of 42 reports of European investigations taken from foreign journals. The total number of titles abstracted was 908, classified as follows: Chemistry—analysis, methods, 29; botany—mycology, 79; zoölogy, 6; entomology—apiculture, 102; meteorology, 32; soils, 20; fertilizers, 57; crops—varieties, composition, field experiments, 190; crops—curing and storage, 10; horticulture, 114; forestry, 2; seeds, 13; weeds, 9; feeding stuffs, 44; animals—breeding, feeding, 61; veterinary science and practice, 18; dairying, 47; technology, 7; agricultural engineering, 16; station statistics, 49; and agricultural statistics, 3.

Facts regarding the stations, the changes in their working corps, additions to their equipment, and new legislation affecting their work were concisely stated in experiment station notes. There were also brief editorial articles giving general statistics of the stations in the United States, Japan, Austria, and Holland; accounts of the meetings of the Associations of American Agricultural Colleges and Experiment Stations, Official Agricultural Chemists, and Economic Entomologists; condensed statements concerning the methods employed in Germany for the improvement of sugar beets, and the investigations by this Department regarding the application of alcohol in the manufacture of sorghum sugar; suggestions regarding methods of investigations of food and feeding stuffs; ways in which the horticultural work of the stations might profitably be extended; a discussion of the value and expediency of farm experiments; and the desirability of special training of a high grade for station workers. The average composition of a large number of American feeding stuffs, as collated by E. H. Jenkins and A. L. Winton, jr., of the Connecticut State Station, is also given in tables.

An effort was made to condense the material in the station publications so as to give only the main facts and conclusions regarding the more important investigations of the stations, with a mere catalogue of the contents of all compilations. The relative space given to abstracts of current bulletins of the stations was thus considerably

reduced in spite of the fact that these publications are now of greater average length and contain more scientific material. The addition of abstracts of the annual reports of the stations, many of which contain more detailed accounts of investigations, and the insertion of reports of European investigations account for the increased size of the second volume of the Record as compared with the first. As it was impracticable for the office to undertake a complete review of the European literature of agricultural investigations, an effort has been made to select those reports in certain lines which promise to be of the greatest interest and value to our station workers. In a few cases brief résumés of the history of investigations in particular lines have been given, and in general the intention has been to record any advances made in those lines on which the office has begun to make reports of foreign work. For example, a résumé of the investigations on the nature and functions of root tubercles was given in two articles by Prof. H. W. Conn, and abstracts of reports of recent investigations regarding the organisms of nitrification and the various problems connected with the acquisition of nitrogen by plants have also been presented. Analyses of feeding stuffs and experiments regarding the digestibility and nutritive value of feeding stuffs have been reported, especially when the investigations on these subjects brought out facts or additional information regarding methods of investigation.

In order to make the material in the Record readily available, a detailed subject and author index, as well as a classified table of contents, were issued with the second volume. While the labor involved in the preparation of the index and table of contents has been very considerable, it is believed that the results of this work will be of great usefulness. The value of the index to the Record is very materially increased from the fact that it is practically an index to the publications issued by the stations and this Department.

Compilation of analyses of feeding stuffs.—The office has in print a compilation of analyses of American feeding stuffs prepared by E. H. Jenkins and A. L. Winton, jr., of the Connecticut State Station. This includes all analyses of American feeding stuffs which were published before September, 1890, and were accessible to the compilers. The analyses are collated from the publications of this Department, of forty-nine experiment stations, and of schools, colleges, and agricultural societies in the United States and Canada. The earliest were analyses of corn made in 1869 in the chemical laboratory of the Sheffield Scientific School under the direction of Prof. S. W. Johnson. The total number of specimens of which analyses are given is 3,273. The analyses are classified as follows: Green fodder—cereal grasses, other grasses, and legumes; silage; hay and dry coarse fodder; tubers—root bulbs and other vegetables; grains and other seeds; mill products; and waste products. The usefulness of such a compilation is obvious.

Index of experiment station literature.—In the report of the office for 1890 reference was made to work upon a general index of experiment station publications and kindred literature. The first installments of this index have recently been issued. Much study has been devoted not only to the general plan and arrangement of the subject-matter of the index, but also to the typographical and other details. The advice and assistance of station workers and of individuals who have had experience in the mailing of indexes has been sought. Special acknowledgment is due to Dr. H. H. Goodell, of Massachusetts, and Dr. W. Frear, of Pennsylvania, who acted as a committee of the Association of American Agricultural Colleges and Experiment Stations to aid this office

in defining its plans for an index. Many opinions regarding the subject-matter of the index have been brought out, and it is not expected that in its present form it will meet all the requirements of individual workers. It is hoped, however, that experience will show that the plan adopted will meet the needs of students of agricultural science as far as could reasonably be expected. The general plan of the index may be briefly outlined as follows: The subjects with which agricultural science deals have been grouped into a limited number of general topics; these topics have been divided and subdivided only so far as seemed necessary to facilitate references to the individual entries of the index. One of the greatest difficulties of the classification of the subjects treated in agricultural science arises from their mixed nature, due not only to their economic relations, but also to their involving matters which under a strictly scientific classification would belong under two or more separate heads. This difficulty is increased by the practical necessity of keeping the index within reasonable limitation as regards size. As far as possible the duplication of entries by cross references is to be avoided in an index of this character. As the work of the stations reaches out in many directions into the realm of pure as distinguished from applied science, it was deemed desirable to set apart a portion of the index for divisions relating to the general principles of the various sciences which lie at the foundation of experimental investigations in agriculture. It should be clearly recognized that any attempted classification of such varied and complex subjects would be more or less unsatisfactory to the individual student, and experience will doubtless show in what direction the classification adopted can be extended and improved. The index is to be printed on cards. Besides the title of the article, name of the author, title of the publication, and a reference to the Experiment Station Record, each card will contain a concise statement of the contents of the article, including especially an outline of the methods and results of investigations. The divisions and subdivisions of the index are plainly indicated by the use of division cards of different colors bearing appropriate printed titles. A key to the index is given below. The index is distributed in installments to each of the agricultural colleges and stations in the United States, where it will be available to the station workers, teachers, and students, and as far as practicable to all persons who may desire to consult it. The index of current American station literature begins with the year 1890. Work has also been begun on the past American literature, and will proceed from 1890 back to the beginning of investigations in agricultural science in this country. As soon as practicable foreign literature will be taken up.

KEY TO SUBJECT INDEX OF LITERATURE OF AGRICULTURAL EXPERIMENT STATIONS AND KINDRED INSTITUTIONS.

[Prepared by the Office of Experiment Stations and published by authority of the Secretary of Agriculture.]

1. GENERAL SCIENCES (including only such general subjects as can not be conveniently indexed under the categories directly relating to agricultural and economic investigations).
    1. Physics.
    2. Chemistry.
        1. Physical.

1. GENERAL SCIENCES—Continued.
    2. Chemistry—Continued.
        2. Inorganic.
        3. Organic.
        4. Physiological.
        5. Technical.
        6. Analytical.
            1. Methods.
            2. Analyses.
    3. Mineralogy. Geology.

1. General Sciences—Continued.
    4. Botany.
        1. Systematic.
        2. Physiological.
        3. Variations in plants.
            1. Crossing (including hybridization).
            2. Acclimatization.
        4. Distribution of plants.
    5. Ferments and fermentation. Bacteriology.
    6. Animal physiology.
    7. Zoölogy (including comparative anatomy and distribution of fauna).
    8. Meteorology. Climatology.
2. Air and Water.
    1. Air.
        1. Physics.
        2. Chemistry.
    2. Water.
        1. Physics.
        2. Chemistry.
    3. Methods of investigation.
3. Soil.
    1. History and classification.
    2. Physics.
    3. Chemistry.
    4. Tillage.
    5. Methods of investigation.
4. Fertilizers.
    1. History, nature, uses.
    2. Farm manures (animal and green manures and composts).
    3. Commercial fertilizers.
    4. Experiments.
    5. Inspection (laws, methods).

(For action of fertilizers on soils, see Soils, physics and chemistry. For fertilizers for special crops, see Crops, manuring. For methods of analysis, see Chemistry, analytical.)

5. Plants.
    1. Field crops (cereals, textile crops, forage plants, potatoes, root crops, sugar beets, sugar cane, sorghum, tobacco, etc.).
        1. History.
        2. Varieties (including crosses and hybrids).
        3. Composition.
        4. Culture (planting, cultivation, harvesting, etc.).
        5. Manuring (see also Fertilizers, experiments).
        6. Curing and storage.
        7. Rotation.
    2. Horticulture.
        1. Vegetables.
        2. Orchard fruits.
        3. Small fruits.
        4. Grapes.
        5. Nuts.
        6. Ornamental horticulture.
            1. Landscape gardening.
            2. Floriculture.
    3. Forestry.
    4. Seeds.

5. Plants—Continued.
    5. Weeds.
    6. Diseases of plants.
        1. Parasitic.
            1. Diseases due to vegetable organisms (fungi, bacteria, etc.)—Economic Mycology. (For diseases due to insects see Entomology, economic).
        2. Nonparasitic.
            Remedies—Fungicides, etc.
6. Foods (Including animal and vegetable substances used for food for domestic animals and man).
    1. Composition and valuation.
    2. Nutritive values (including digestibility and potential energy).
    3. Preparation and use.
    4. Food accessories, condiments.
    5. Beverages.
    6. Adulterations.

(For methods of analysis, see Chemistry analytical. For methods of feeding, see Animal production. For functions in nutrition, see Animal physiology.

7. Animals (Breeding and care of domestic animals, including feeding for beef, milk, mutton, pork, and work).
    1. History and general principles.
    2. Breeds and breeding.
    3. Animal production.
        1. Cattle-raising.
        2. Dairy farming.
        3. Sheep husbandry.
        4. Swine husbandry.
        5. Horse and mule husbandry.
        6. Aviculture.
    4. Veterinary science and practice.
8. Entomology (Economic).
    1. Beneficial insects.
        1. Apiculture.
        2. Sericulture.
    2. Injurious insects.
        1. Insects affecting animals.
        2. Insects affecting plants.
        3. Insecticides.
        4. Insecticide appliances.
9. Dairying.
    1. History and general principles.
    2. Composition and properties of milk and its products.
    3. Changes in milk.
        1. Fermentative changes (bacteria, etc.).
        2. Creaming of milk.
    4. Handling of milk (milk supply).
    5. Inspection (laws, methods).
    6. Butter-making, creamery.
    7. Cheese-making, cheese factories.
10. Technology.
    1 Milling.
    2. Starch.
    3. Sugars.
    4. Fermented liquors.
    5. Fats, oils.

N. B.—The index is arranged on a decimal system, the number on the card before the decimal point representing one of the grand divisions of the index and the numbers after the decimal point representing subdivisions of the several grades. Thus on a card numbered 12.34: 12 = Statistics, .3 = Equipment, .04 = Implements. A card numbered 1.432 belongs under acclimatization (of plants); 2.22, chemistry of water; 9.32, creaming of milk.

THE AGRICULTURAL EXPERIMENT STATIONS.

The interest manifested in the work of the stations by farmers and the general public has steadily increased as the stations have become better established and the results of their work have been more widely disseminated. The stations in most of the States have settled on the lines of investigation which they intend to pursue. They are making more careful inquiries regarding the best methods of research. Their purpose to work in the interest of the several communities in which they are located is as strong as ever. At the same time they appreciate the fact that only carefully planned and thoroughly conducted experiments can bring results of value. The desire for such coöperation as will be mutually beneficial grows stronger as it becomes increasingly evident that a single station can cover properly only a narrow range of subjects. The rapid awakening of the farmers to a desire for information regarding the results of experimental inquiry affecting their practice has put upon the stations a heavy burden in the preparation of popular compilations. Justification for this work, which to a certain extent takes the stations away from original research, lies in the fact that by this means they gain the immediate friendship of a host of farmers and thus may reasonably hope for a stronger support from the people on whom they must depend to provide larger means for research. In this country a great deal depends upon the kind of constituency which a station has. If the farmers are intelligent and awake to their best interests, the station can better maintain a high grade of useful work. It is in those communities where the agricultural classes are ignorant or indifferent that the stations are in danger of falling into the hands of incompetent management.

The work of the agricultural experiment station as organized is varied: (1) It acts as a bureau of information regarding all questions of practical interest to the farmers of its locality; (2) it seeks by practical tests to devise better methods of agriculture and to introduce new crops and live stock, or to establish new agricultural industries; (3) it aids the farmer in his contest with insects and with diseases of his crops and live stock; (4) it defends the farmer against fraud in the sale of fertilizers, seeds, and feeding stuffs; (5) it investigates the operations of nature in the air, water, soil, plants, and animals in order to find out the principles which can be applied to the betterment of the processes and products of agriculture. When we consider how brief has been the life of most of our stations and how much there is to be done in every State

in the immediately practical lines of work, we feel very confident that our stations have been worth far more than they cost to our farmers as sources of useful and stimulating information. In most of our communities agriculture has run in comparatively narrow and traditional lines. It is only within a few years that farmers have felt the necessity for more careful and thoughtful attention to the improvement of their work. In our newer and some of our older communities the stations could find sufficient employment in pioneer experiments, by which the farmers might be taught what crops they should introduce and what abandon, how agriculture could be more diversified, and how the resources of soils and water could be best utilized or husbanded. If our stations are for the most part working in these practical lines it is because there is such imperative need on the part of the farmers for advice and direction in those ways which do not involve the discovery of new principles, but only the application of old ones to peculiar circumstances and conditions. The farmer in New York needs to know what breed of dairy cows will best serve his purpose, the farmer in Nebraska whether sugar beets can be profitably grown there, the farmer in Colorado how the scanty rainfall can best be supplemented with irrigation water, the farmer in Oregon or Wyoming what crops can be grown on his virgin soils, the farmer in Florida or California what varieties of fruits will be best for the soils and the climate of the region. The station can help to find the answers to such questions by practical experimenting. Though such work is along well-established lines and involves only careful planning and patient attention to details, it may nevertheless serve most useful ends, and the money spent for this purpose may save the useless expenditure of large sums by individuals. It is eminently proper that the stations should work in these lines. It is their duty to select those problems which have the widest range, and to undertake only as much as they can carry out thoroughly.

But while the stations are already doing work which is of such value to the farmers that they are receiving stronger support each year, they are not losing sight of the deeper problems relating to the scientific principles on which the widest improvement of agriculture depends. As far as practicable the scientists connected with our stations are giving themselves to these higher researches. Such work necessarily involves much patient study and investigation before results of value can be reached. In this kind of inquiry our workers form but a small part of that large body of investigators throughout the world who are laboring on the same problems.

It is very encouraging to observe that within the past year a decided advance has been made in one line of investigation on which studies have been pursued for many years. The question has been whether the inexhaustible store of nitrogen in the air could be utilized by plants, and if so by what process this nitrogen was made available as plant food. For many years the experiments made seemed to indicate that the nitrogen of the air was not taken up by plants, but about ten years ago an American investigator performed experiments which showed that some kinds of plants do acquire nitrogen from the air. These results were confirmed by experiments elsewhere, and it was next shown by experiments in Germany that this power to acquire atmospheric nitrogen which leguminous plants possess was connected with the tubercles which are produced on the roots of those plants. Then the fact was brought out that minute organisms in the soil had to do with the production of these root tubercles. It now appears from the latest investigations that there are different kinds of organisms

which accomplish this work for different kinds of plants. Thus, if we wish to produce tubercles on the roots of lupines, we must grow the plants in soil which contains the lupine bacteria. As, step by step, the several processes involved in the acquisition of atmospheric nitrogen by plants have been worked out, there is good reason for believing that further investigations will clear up those points about which there still is doubt. It will then remain to find out what practical advantage can be taken of the knowledge which we thus obtain. Already it has been shown in a few trials that an increase in the yield of leguminous crops can be caused by spreading small quantities of soil from fields where legumes have previously been grown, over ground where another crop of the same kind of legumes was to be grown. The bacteria in one soil were thus transmitted to another, to aid in supplying the new crop with nitrogen from the air. Science has thus far taught that the chief uses of tillage and manuring are to regulate the moisture of the soil and to provide proper food for plants. In the inoculation of soil with bacteria we seem likely to have another means for increasing the growth of crops. The state of our knowledge regarding this subject is the result of what has already been done and what is being done by investigators in agricultural science throughout the world.

LINES OF WORK PURSUED BY THE STATIONS.

On page 534 will be found a table showing the lines of work pursued at the several stations. The nature of the investigations in progress in the different lines was briefly described in the report of the office for 1890. The following are some illustrative statements regarding experiments reported in station publications which were abstracted in the second volume of the Experiment Station Record. Of course many of the investigations at the stations must be continued for years before definite conclusions can be drawn from them. The bulletins thus far issued by the majority of our stations have been very largely reports of progress. In many cases these have given suggestions of value, though the main problems involved in the research still remain unsolved.

Meteorology.—Observations at the Colorado Station as compared with those at the New York State Station showed that the per cent of sunshine in 1889 at the former place was 64.7, while the average per cent for several years in New York was only 37. The average yearly rainfall at the Colorado Station is only about 14 inches. In New York it was about 27 inches. It is evident that the relatively large amount of sunshine and the small precipitation in Colorado necessarily make the conditions of agriculture there very different from those in New York, even though we leave out of account other important differences relating to soil and climate. Fears have been expressed that our stations would needlessly duplicate inquiries in the same lines. As regards certain branches of their work this may easily be true, but in the main it may safely be asserted that as long as there are only one or two stations in each State there is good reason in many cases for their working together on the same problems. In meteorology in particular very little has yet been done to study the relations between the weather and the growth of crops. There is abundant opportunity at every station which is equipped for work in this line to collect those data from which, after the lapse of years, it may be possible to draw conclusions of value to the farmer. At the Louisiana Sugar Station, now located at Audubon Park, New Orleans, observations on the weather as related to the

growth of sugar cane have been made since 1886, from which it appears that "a dry, warm winter, followed by a moderately dry spring, and this in turn succeeded by a hot, wet summer, shading gradually into a cool, dry autumn, are conditions favorable to the maximum growth of cane. After the cane is laid by, frequent showers of considerable intensity seem highly beneficial."

Soil.—At the Wisconsin Station the study of problems connected with the physics of the soil has been undertaken in the field as well as in the laboratory. Among the observations already reported are the following, which are of immediately practical interest: It has been found that at times the distribution of water in the soil changes quite rapidly. Firming the surface soil draws water up from beneath. Rains also frequently give rise to a translocation of water. Observations on samples of soil taken at different depths before and after a rain or artificial sprinkling showed a marked decrease in the amount of water in the subsoil when the surface soil was wet. From this it appears that unless the ground is already too wet the stirring of the surface soil, wherever practicable, should follow as soon after a considerable rainfall as the tools will work well. The cultivation should as a rule be shallow, leaving a thin stratum of the surface soil finely pulverized and completely cut off from the ground below. If this is not done the extremely rapid evaporation which takes place from undisturbed wet soil on hot, clear days, even in a few hours, not only dissipates that which has just fallen, but also a part of that which the rain has caused to be drawn toward the surface from lower levels, and thus leaves the ground actually drier as a whole than before the rain, even though it may look more moist at the surface.

When dry weather follows the planting of trees, it will be evident that simply wetting the surface may in some localities do more harm than good, because in these cases the roots, lying as they do at considerable depths, can not use water which remains at the surface, and as surface wetting may diminish the water content of the deeper soil, the soil about the roots is liable to be rendered drier than before the wetting.

Fertilizers.—In connection with the inspection of fertilizers by the Connecticut State Station in 1890, it was found that out of ninety-eight brands analyzed, thirty-five, or more than one-third, contained less of a single ingredient than was required by the manufacturer's guaranty. Several of the brands that were specially recommended for potatoes were found to be without special adaptation to that crop. And in general it would seem that manufacturers' views regarding a good fertilizer for potatoes differ as widely as those of farmers. Analyses of fertilizers by the Mississippi Station indicated very clearly that extensive frauds were being practiced in the sale of commercial fertilizers in that State and that there was great need of a fertilizer law to protect purchasers.

In New Jersey, when the analysis of fertilizers was begun by the station, on its establishment in 1880, sixty-four samples were analyzed during the year, of which thirty-one were "complete" fertilizers, representing the productions of twenty-one manufacturers. In 1890 five hundred and forty samples were received at the station laboratory, two hundred and six of which represented different brands of complete fertilizers from sixty-one firms. The chief causes of this increase were:

(1) Demands for special crop fertilizers; (2) the increasing number of small factories; (3) a growing tendency on the part of large dealers to have goods prepared according to their own formulas; and (4) the increased efficiency of the system of inspection adopted by the station in 1884. The station believes that further

multiplication of brands is not desirable, since the quality of the fertilizers and the quantity applied are more important factors in increased crop production than soil variations if the relative proportion of the nitrogen, phosphoric acid, and potash is contained in them.

Of one hundred and twenty-six complete fertilizers analyzed, seventy were below guaranty in respect of one or more ingredients, though only two were below in all respects.

In thirty-five cases the deficiency is counterbalanced by an exhaustive amount of some other available ingredient. Of the remainder, many are so near as to make the difference hardly appreciable in dollars and cents. While there is ample evidence of irregularity in mixing and carelessness in statement of guaranty, no attempt at fraud has been discovered.

In New York the State Station has been given extensive powers to carry on fertilizer inspection, and during the year past has issued the first numbers of a series of bulletins giving information regarding the composition of fertilizers as well as the results of analyses of samples collected by the agents of the station. The California Station reports that it is already apparent that soils in that State which have long been occupied or heavily cropped are beginning to require care to maintain or restore their productiveness.

In a great many instances the failure to produce satisfactory crops is not at all due to soil exhaustion, but to improper physical conditions of the subsoils, unsuitable cultivation or irrigation, alkali, etc. The fact that orchards and vineyards form costly investments of much greater permanence than the annual crops that occupy the vast majority of the cultivated land east of the Rocky Mountains, and the high returns so often realized from them, have brought the manure question forward here much earlier than has usually been the case in the United States.

Most of the soils of California contain an abundance of available potash, but phosphoric acid is very much needed in the nonalkaline soils and nitrogen in the upland soils, especially the mesa soils of the southern part of the State, where citrus fruits largely grow. Fertilizer inspection is already needed in California. In Indiana 29,000 tons of commercial fertilizers, valued at $882,100, were sold during 1890; but this was less than 3 per cent of the value of the nitrogen, phosphoric acid, and potash exported from the State in corn and wheat alone during the same year. In Ohio, where a dozen years ago the use of commercial fertilizers was almost unknown in a large part of the State, statistics collected during recent years indicate that the use of such fertilizers is steadily increasing and that the farmers of the State are now spending not less than $1,000,000 annually in their purchase.

Field experiments with fertilizers by twenty different stations were reported in the second volume of the Record. The great variety in the results obtained from these experiments illustrates anew the importance of studying the needs of particular soils and crops. It also becomes more apparent that not only the chemical composition of soils and fertilizers must be considered, but their physical condition as well. For example, in experiments with different fertilizers on corn, carried on by the Connecticut Storrs Station on seven farms in different parts of the State, in four cases the results favored phosphoric acid, in two potash, and in one all three elements seemed to be needed; and while in the majority of cases the largest yields were obtained when complete fertilizers were used, the best financial results were not as a rule secured from such mixtures. Similar experiments at the Kentucky Station have shown a profit in every instance where potash fertilizers were used, and a loss when dissolved boneblack and nitrate of soda were used without potash, indicating that fertilizers containing large quantities of potash should be used for corn on soils of like character in the blue-grass

region. Experiments at the station and by farmers in seven counties of Ohio have indicated that on soils capable of producing 50 bushels of shelled corn per acre with good drainage and tillage, fertilizers are at present unprofitable, and that on soils decidedly deficient in natural fertility fertilizers may be used with profit, though whether phosphoric acid, potash, or nitrogen should be the leading element of such fertilizers can only be determined by actual test, since the results of experiments have been quite varied.

Diseases of plants.—A number of the stations have reported studies on the diseases of plants, especially those due to the action of fungi. New species of fungi have been discovered and the life history of many formerly known has been traced out. Special attention has been given to the treatment of fungous diseases, particularly by the use of fungicides. The New Jersey Station has published the results of recent investigations of certain fungous diseases of the sweet potato. The diseases and the fungi which caused them were clearly described and illustrated with figures. These diseases are a soft rot, black rot, stem rot, white rot, dry rot, sweet-potato scurf, leaf-blight, and leaf mold. At the same station four species of parasitic fungi, namely, mildew, anthracnose, leaf-blight, and white smut, were found on spinach. The anthracnose and white smut appeared to be newly discovered species, the former being very destructive. This is an important matter in New Jersey, where large quantities of spinach are grown under glass during the winter. A kind of clover rust which has not been long known in America, but which prevailed to a large extent in many sections of the Northern States during the several wet, cold seasons preceding 1890, was studied at the New York Cornell Station. It was found that while the early crop of red clover is not likely to suffer injury from rust, the second crop is likely to suffer greatly if the midsummer is cool; and the conclusion was reached that as clover becomes a valuable fertilizer when plowed in, the fields should be carefully watched in such seasons and the crop plowed under if the rust appears on it.

At the Connecticut State Station the important discovery was made that at least one form of potato scab was due to the direct action of a very peculiar fungus of extremely small dimensions, which was invariably found to accompany the disease wherever it was examined in New England.

In the last annual report of the office a root rot of cotton caused by a fungus was described from studies made at the Texas Station. More recently observations at the Alabama College Station have shown that the roots of cotton may be seriously injured by a nematode worm. The appearance of the plant attacked by the nematode is very like that caused by the fungus, and careful observations need to be made to distinguish between the two diseases. There is no thorough remedy for the nematode worms after the land is once infected by them, so that care should be taken not to plant infected roots. Rotation of crops and clean culture are the chief means advised for reducing the number of these worms.

Experiments have been made at the Kansas Station with a large number of different fungicides for the stinking smut of wheat. The most effective and by far the cheapest treatment has been found to be that originally recommended by Jensen, of Denmark, which consists in immersing the seed in hot water for a few minutes. As the result of experiments at the Kansas Station the following suggestions are made for the treatment of large quantities of seed:

Provide two large vessels, as two kettles over a fire or boilers on a cooking stove, the first containing warm water (say 110°–120° F.), the second containing scalding water (131°). The first is for the purpose of warming the seed preparatory to dipping it into the second. Unless this precaution is taken it will be difficult to keep the water in the second vessel at a proper temperature.

The seed to be treated must previously be placed in a barrel or other large vessel filled with water and be stirred till all the grains are wetted and the smutted and imperfect ones rise to the surface. These must be removed by skimming. The grain may remain in the water a few minutes or even half an hour. Then it must be removed and placed, a half bushel or more at a time, in a vessel that will allow free entrance and exit of water on all sides.

For this purpose a bushel basket made of heavy wire could be used, over which stretch wire netting, say twelve meshes to the inch; or an iron frame could be made at a trifling cost, over which the wire netting could be stretched. This would allow the water to pass freely and yet prevent the passage of the seed. A sack made of loosely woven material (as gunny sack) could perhaps be used instead of the wire basket.

Now dip the basket of seed in the first vessel; after a moment lift it, and when the water has for the most part escaped plunge it into the water again, repeating the operation several times. The object of the lifting and plunging, to which might be added also a rotary motion, is to bring every grain into contact with the hot water. Less than a minute is required for this preparatory treatment, after which plunge the basket of seed into the second vessel. If the thermometer indicates that the temperature of the water is falling, pour in hot water until it is elevated to 131°. If it should rise higher than 131° add some small quantities of cold water. This will doubtless be the most effectual method of keeping the proper temperature, and requires only the addition of two small vessels—one for cold and the other for boiling water. The basket of seed should very shortly after its immersion be lifted and then plunged and agitated in the manner described above; and the operation should be repeated eight or ten times during the immersion (which should be continued fifteen minutes). In this way every portion of the seed will be subjected to the action of the scalding water. Immediately after its removal dash cold water over it or plunge it into a vessel of cold water, and then spread out to dry. Another portion can be treated similarly, and so on till all the seed has been disinfected.

The important precautions to be taken are as follows: (1) Maintain the proper temperature of the water (131°), in no case allowing it to rise higher than 135° or to fall below 130°. This will not be difficult to do if a reliable thermometer is used and hot or cold water be dipped into the vessel as the falling or rising temperature demands. Immersion fifteen minutes will not then injure the seed. (2) See that the volume of scalding water is much greater (at least six or eight times) than that of the seed treated at any one time. (3) Never fill the basket or sack containing the seed entirely full, but always leave room for the grain to move about freely. (4) Leave the seed in the second vessel of water fifteen minutes.

Similar experiments at this station on the loose smut of oats have shown that the hot-water treatment was equally effectual for this disease. Important experiments at the Indiana Station have confirmed the results obtained at the Kansas Station as regards the value of hot-water treatment for smut of both wheat and oats. It has also been observed in the experiments at the Kansas Station that treatment of the seed with hot water not only destroyed the smut, but also gave a yield of grain greater than would be expected from merely replacing the smutted heads with sound ones.

Entomology.—As the result of investigations by the entomologist of the Massachusetts Hatch Station, which called attention to the fact that the gipsy-moth, an insect which feeds upon a great variety of plants and which was accidentally introduced into this country about twenty years ago, has become acclimated in certain localities in eastern Massachusetts, where it has done considerable injury to the fruit crop and the foliage of shade trees, a law was passed by the Massachusetts legislature giving the State board of agriculture extensive power to take measures for the extermination of the insect.

At the Maine Station an extensive investigation of the apple-maggot has been made, in the course of which the eggs of the maggot were discovered and other important facts regarding the life history of this

insect were clearly brought out. The destruction of windfalls and the burning of the refuse from bins and barrels are urged as the most effectual means of repressing the maggots.

The entomologist of the New Jersey Station has published a copiously illustrated bulletin describing his observations on the following insects injuriously affecting cranberries, with suggestions as to remedies: The black-headed cranberry worm, yellow-headed cranberry worm, cranberry fruit worm, tip worm, cranberry scale, grasshoppers, locusts, and cranberry leaf-hoppers.

The Nebraska Station has issued illustrated accounts of a large number of insects which are injurious to young trees on tree claims, with suggestions as to the repression of these insects by the use of insecticides and other means.

At the Arkansas Station experiments have been made with a number of substances in the effort to find an effectual remedy for the cotton worm which could be generally used and which would not be as dangerous to handle as are the arsenic compounds. Among the new materials tried, veratrin, which is about as expensive as Paris green, was quite satisfactory in its action in killing the insects by contact and when they ate it. An emulsion of kerosene with pyrethrum was also found to be quite effective. As used at the station, 1 gallon of the extract of kerosene with pyrethrum cost 65 cents, and 1 pound of soap 10 cents. When this was diluted with 450 gallons of water it gave a sufficient quantity of the mixture to spray 15 acres of cotton, at a cost of about 5 cents per acre. An account of the use of a combination of kerosene emulsion and pyrethrum was first published in 1889, in a bulletin of the Iowa Station, where it has been successfully used for false chinch-bugs, cabbage-worms, red spiders, and plant-lice. At several stations experiments have been made with reference to the injuries caused to foliage by the application of Paris green, London purple, and white arsenic. Investigations at the Iowa and North Carolina Stations have brought out the fact that the addition of lime to solutions of London purple or Paris green would largely prevent the injuries to the foliage. It was ascertained that these injuries were due to the solubility of the arsenic, and that this could be rendered insoluble by the addition of lime.

Field crops (*composition, manuring and cultivation, varieties, rotation*).—Under this head are included numerous field and laboratory experiments with barley, corn, cotton, flax, grasses, clovers, and other forage crops, oats, potatoes, ramie, rye, sorghum, sugar beets, sugar cane, tobacco, and wheat. As illustrating the range of the experiments the following topics included in reports on corn in the second volume of the Record are given: Analyses of entire plant, cob and kernels; methods of cultivation; effect of fertilizers on growth and on composition; effect of topping and stripping; the use of seed from different ears and different parts of the ear; harvesting at different stages of growth; improvement by cross fertilization and selection; planting at different dates, depths, and distances, in hills or drills or by listing; observations on root growth of corn, and the effects of root pruning; rotation as compared with continuous cropping; tests of varieties.

Stations in a number of States have undertaken investigations with reference to the introduction of the sugar-beet industry. Reports on this matter from Indiana, Iowa, Colorado, New York (Cornell), Nebraska, South Dakota, Minnesota, Michigan, Wisconsin, and Nevada are included in the second volume of the Record.

The Louisiana Sugar Station has been largely engaged in experiments with reference to the improvement of sugar cane, and has collected for

this purpose more than one hundred of the so-called varieties of sugar cane from different parts of the world.

Horticulture.—The work of the stations in horticulture consists largely in the testing of new varieties of vegetables, and large and small fruits, and of old varieties with reference to their introduction into localities where they have not hitherto been grown. The continuance of this work brings out with increasing clearness the fact that a vast majority of new varieties produced are no better than those now in common use, and that as a rule such varieties should be subjected to tests by experts in different localities before it is worth while for the farmer to try them, unless he has abundant time and means for experimenting. More and more the station horticulturists are seeking ways in which to enlarge the scope of their work, especially in the direction of the improvement of plants by selection and cross fertilization. Among experiments in this line already reported may be mentioned those with cucurbits, eggplants, and tomatoes at New York Cornell Station. Experiments with fertilizers on tomatoes have been reported from Delaware, Virginia, New York Cornell, and Maryland Stations. Tests of American-grown cauliflower seed, as compared with the imported seed at the Minnesota Station, have indicated that seed grown in the region of Puget Sound is as good as that brought from abroad. Experiments with reference to the introduction of Russian varieties have been recorded by several stations, especially in the Northwest. Questions relating to the best stock on which to graft different kinds of fruits have been made at the Iowa and Texas Stations. Other problems relating to grafting have been studied at the New York Cornell Station. The California Station is engaged in investigations with reference to the production of varieties of olives, oranges, and lemons especially adapted to that State. Questions relating to the construction and heating of greenhouses have received attention, particularly at the Michigan and Massachusetts Hatch Stations. An investigation with reference to the use of the electric light in greenhouses has recently been reported from the New York Cornell Station. The results seem to indicate that electric light may yet be utilized in horticulture.

Seeds.—Tests of seeds with reference to their purity and vitality have been made at a number of the stations. The results have shown that the seeds of vegetables purchased from reliable dealers are as a rule free from impurities and of good germinating power. In some cases, however, the practice of mixing old and new seeds together seems to prevail, and many of the small dealers in country towns sell old seeds which are comparatively valueless. This is most likely to be true in the case of those varieties of seeds which are more rarely called for. As regards the seeds of grasses and clovers a much worse condition of things has been found. These seeds, so far as tested, have been found to be largely mixed with certain inferior seeds. In many cases large numbers of seeds of weeds which spread rapidly and are very difficult to eradicate, have been found in the samples of grasses and clovers examined. On the whole, the evidence shows the necessity for great care on the part of farmers in the choice of seeds to plant on their farms.

Feeding stuffs.—A large number of analyses of different feeding stuffs were made at various stations during the past year. Special chemical studies of silage and of fodder corn cut at different stages of growth were reported. Important digestion experiments are being carried on at the Maine Station, and interesting data obtained from them have been published in the annual reports of the station. The compilation

of analyses of American feeding stuffs prepared at the Connecticut State Station has already been referred to.

Feeding of animals.—In May, 1889, a series of experiments was commenced at the New Jersey Station with Ayrshire, Guernsey, Holstein-Friesian, Jersey, and Shorthorn cows, with a view to determining the cost and value of the products from each of the different breeds. Three representative animals of each breed were selected by committees from associations interested in the several breeds. These experiments were prematurely terminated by a fire November 2, 1890, which burnedthe barns at the agricultural college and the entire herd of cows. Though no definite conclusions were reached regarding the main question for which the experiments were instituted, many interesting facts were brought out in the report published by the station. For example, it was observed that—

> The total solids in the milk of all the breeds was lowest during the summer months. A great decrease in quality was noticed from April to June and increase from September, though the actual food compounds eaten were as uniform as possible, and the period of greatest milk flow did not occur for all the animals during the months from June to September, inclusive. It would seem therefore that summer conditions of food and weather, which as a rule favorably influence milk flow, did so at the expense of quality. * * * The average yield of milk per day indicated that on the basis of milk production the five breeds represented three classes, the Guernseys and Jerseys with an average of 8.5 quarts, the Ayrshires and Shorthorns with an average of 9 quarts, and the Holsteins with an average of 11 quarts. * * * The cost of food per pound of fat was low in those breeds whose milk showed a high content of fat, and high in those showing a low content of fat. But the lowest daily averages were not accompanied by the highest cost, and on the basis of cost per pound of butter the breeds were again divided into the same three classes. The cost per pound of butter fat as a rule was greatest in the breeds whose average daily yield of milk was the largest. Studied under the conditions which now largely rule in the sale of the distinct dairy products, milk and butter, and which must define the present methods of comparison from a commercial standpoint, the results show that all the breeds do not represent the same points of comparison, but are divided into distinct classes—one milk, the other butter. In the milk class the average cost of a quart of milk is less than in the butter class, and in the butter class the average cost of a pound of butter is less than in the milk class.

Experiments with Ayrshire, Holstein, and Jersey cows have been carried on at the Maine Station for two years. It has been observed that—

> The expense of feeding a Holstein animal averaging 1,200 pounds in weight is only $11 per year more than the cost of feeding a Jersey animal averaging in weight about 900 pounds; or, in other words, the expense of feeding the heavier animals has been only about 18 per cent more than that of maintaining the lighter animals, whereas the Holsteins exceed the Jerseys in weight about 33 per cent. This is equivalent to saying that the quantity of food has not been in proportion to the weight of the animal. * * * It is a well-recognized fact that the food of an animal does not increase in proportion to the increase in weight; or, in other words, a small cow requires a larger maintenance ration in proportion to her weight than a large cow. The Holsteins produced milk solids considerably in excess of the other two breeds, and the Ayrshires and Jerseys differed very little in this respect. The yield of fat was largest from the Jersey cows and smallest from the Ayrshires. The food value of a quart of Jersey milk such as that produced by the station animals was worth 25 per cent more for purposes of nutrition than was the Holstein milk. The cream from the different animals was not of uniform value, the individuality of the animals having a very marked influence upon the cream. Taking the average of the two years' record, the amount of cream required for a pound of butter varied from 5.2 pounds in the case of an Ayrshire cow to 3.95 pounds in the case of a Jersey cow. When quantity alone is considered, Holstein milk cost the least and the Jersey milk the most, but the butter fat in the milk of the Ayrshire and Holstein cost on an average from 20 to 30 per cent more than in the case of the Jersey.

Experiments at the Texas Station as to the effects of feeding cotton seed and cotton-seed meal on butter production indicated that the

feeding of cotton seed or cotton-seed meal beyond a certain limit lowers the quality of butter, and that a mixture of cotton-seed meal, corn meal, and wheat bran in connection with pasturage or green fodder is a satisfactory ration for milch cows. Cotton seed or cotton-seed meal renders butter much lighter in color than is normal. The case is cited of a Jersey cow whose butter, rich in color when no cotton seed was fed, became "almost as white as tallow" after feeding cotton seed exclusively for two weeks, the normal color returning when other rations were substituted for the cotton seed.

The New York State Station made experiments for two years with a number of different feeding stuffs with reference to their influence on butter. It was found, in general, that the character of the food did largely influence both the yield and the quality of butter.

Of all grain foods tried, gluten meal gave the largest flow of milk, but the per cent of fat was exceptionally low. Dry feed, a waste product from the manufacture of starch, and glucose from corn ranked next to gluten meal. Corn meal followed these for producing flow of milk. Linseed meal gave the largest amount of butter, but the quality was not of the best, being too soft. Oats gave the best-colored and hardest butter, but somewhat crumbly. A combination of foods was the most satisfactory butter ration.

In an experiment at the Wisconsin Station in fattening wether lambs it was found that a ration of shelled corn, corn silage, and corn fodder produced the largest gain in weight at the least cost. A comparison of the results of forty-four experiments in fattening steers with the results with the wether lambs indicated that the latter made a more economical gain than did the steers.

The following conclusions were drawn from a number of experiments in feeding pigs at the Wisconsin Station:

Having now completed four years of feeding trials, where special reference was had to the effects of food upon the carcass, we feel warranted in maintaining that the kind of food supplied to young growing pigs has a very marked effect upon the animal carcass; that foods rich in protein tend to build up strong, muscular frames and large individuals, with ample blood and fully developed internal organs; that exclusive corn-feeding with pigs, even after they have obtained a good start on proper food, tends to dwarf the animal in size and prematurely fatten it; that owing to the larger amount of ash contained, and perhaps for other causes, pigs receiving the usual nitrogenous foods have stronger bones than those of pigs fed on corn, and that the bones of pigs fed on corn contain the least mineral matter. We have further found that where growing pigs are fed exclusively on corn, the strength of the bones and the quantity of mineral matter they contain can be greatly increased by feeding mineral matter in the shape of hard-wood ashes or ground bone. * * *

It appears plain to us that the excessive feeding of corn, with its deficiency in ash, tends to repress the natural development of the muscles, reduces the blood and some of the internal organs of the body, and gives weak bones. Supplying nitrogenous foods to growing pigs so nourishes the body that the muscles and internal organs are developed to normal size, and the blood is abundant. With these foods there is usually an abundant accompaniment of ash, which nourishes the bones, giving them their normal strength.

Dairying.—Among the topics treated in the second volume of the Record in reporting the work of the stations on dairying, were analyses of milk of different cows and breeds under varying conditions; investigations regarding the composition of milk with special reference to fibrin, and the number and size of fat globules; descriptions of rapid methods for determining the fat in milk, with accounts of tests of these methods at different stations; bacteria in milk, cream, and butter; cream-raising by dilution; variations in the fat of milk to customers in dipping from cans; preservatives for milk samples; the relative value plan at creameries, and tables for calculating prices for milk; and butter-making from sweet and sour cream.

COLLEGES AND SCHOOLS HAVING COURSES IN AGRICULTURE.

To provide for the better endowment and maintenance of the colleges for the benefit of agriculture and the mechanic arts established in accordance with the act of July 2, 1862, Congress passed an act, approved August 30, 1890, making grants of money to these institutions. The chief provisions of this act are as follows:

Annual appropriations are to be made out of the proceeds of sales of public lands, to each State and Territory; $15,000 are appropriated for the year ending June 30. 1890, and there is to be an annual increase of $1,000 in the amount of the appropriation thereafter for ten years, after which time the annual amount to be paid to each State and Territory is to be $25,000. These funds are to be applied only to instruction in agriculture, the mechanic arts, the English language, and the various branches of mathematical, physical, natural, and economic science, with special reference to their applications in the industries of life, and to the facilities for such instruction. It is also stipulated that no money shall be paid under this act to any State or Territory for the support and maintenance of a college where a distinction of race or color is made in the admission of students. But the establishment and maintenance of such colleges separately for white and colored students shall be held to be in compliance with this act if the funds received under the act are equitably divided between the two races. Payments of appropriations from the United States Treasury are to be made on the warrant of the Secretary of the Interior, and detailed reports of the amounts so received and of their disbursement are required to be made to the Secretary of Agriculture and to the Secretary of the Interior on or before the first day of September of each year. No portion of these funds can be applied to the purchase, erection, preservation, or repair of any building or buildings. In case these funds are in any way diminished, lost, or misapplied in any State or Territory, the loss must be made good by the State or Territory before it can receive further appropriations under this act.

An annual report regarding the condition and progress of the college must be made by the president of each of the colleges receiving the benefits of the act, to the Secretary of Agriculture and to the Secretary of the Interior. This report must include statistical information relating to receipts and expenditures, libraries, number of students and professors, and also as to any improvements and experiments made under the direction of any experiment station attached to the college, with the cost and results, and such other industrial and economical statistics as may be regarded as useful. If for any reason the Secretary of the Interior shall refuse to certify that any State or Territory is entitled to receive its share of the annual appropriation under this act the facts and reasons for this refusal must be reported to Congress, in order that the State or Territory may have an opportunity to appeal to Congress from his decision. The Secretary of the Interior is charged with the proper administration of the law and is required to report to Congress the disbursements made under this act and whether the appropriation of any State or Territory has been withheld, and if so the reasons therefor.

The Secretary of Agriculture has made this office the depository of the reports received in accordance with this act. The character of the reports required seems to make it clear that it was the intention of Congress that the Department of Agriculture should aid in disseminating information regarding the ways in which these grants are applied for the benefit of the industrial arts. It is therefore the purpose of this office to present annually tabular and other statements regarding the work of the colleges of agriculture and the mechanic arts. It has not proved practicable, however, to make such a report this year. Owing to long delays in the payment of the installments due the colleges, the policy in the use of these funds is not as yet clearly indicated. It is expected that it will be possible to prepare for the next annual report a somewhat extended account of the workings of these institutions.

THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

The Association of American Agricultural Colleges and Experiment Stations held its fifth annual convention August 12–18, at Washington, D. C., in the lecture rooms of the Columbian University. There were present one hundred and twenty-five delegates and representatives of colleges and stations in thirty-seven States and Territories, and of the United States Department of Agriculture. About the same time occurred the meetings of the American Association for the Advancement of Science, the Association of Official Agricultural Chemists, the Society for the Promotion of Agricultural Science, the Association of Economic Entomologists, and the Conference of American Chemists.

A salient feature of the convention of colleges and stations was the lectures of Mr. R. Warington, F. R. S., chemist of the experiment station at Rothamsted, England. This course of six lectures was the first to be delivered under the provisions of the Rothamsted trust, instituted by Sir John Bennet Lawes. The subjects treated were: The Rothamsted Experimental Station; the circumstances which determine the rise and fall of nitrogenous matter in the soil; nitrification; nitrification and denitrification; nitrification of soils and manures; drainage and well waters. Mr. Warington's description of the work of the Rothamsted Station and his more detailed accounts of the processes and results of the investigations of problems of nitrification were followed with much interest by the scientists present, and will constitute a valuable contribution to the literature of scientific investigations in agriculture. A full report of these lectures and of the proceedings of the convention will be issued as bulletins of this office at an early date.

Dr. H. H. Goodell, president of the Massachusetts Agricultural College and director of the Massachusetts Hatch Station, presided at the session of the first day of the convention, but was afterwards compelled by indisposition to yield the chair to Vice-Presidents Roberts, of New York, and Porter, of Missouri, for the remainder of the meeting. In his annual address President Goodell urged the necessity for untiring patience and perseverance in scientific research in order to attain the highest success, enforcing his argument with illustrations from the lives of eminent workers in general and agricultural science and from the carefully planned and thoroughly executed experiments conducted for so many years by the Rothamsted Station.

In accordance with the plan adopted by the association, the section on agriculture presented two topics deemed of general interest to the convention. The first was the question, "How can the results of station work be most successfully presented to the farmer?" The leaders in the discussion of this question were Director Roberts, of New York, and President Scott, of New Jersey. Mr. Roberts urged that the station worker make himself thoroughly familiar with the environment and life of the average farmer. Since the work of the farmer was so exacting as to leave him but little time and strength for reading, the station bulletins should be attractive in appearance, brief in form, and simple in language. Well-executed illustrations would greatly enhance the popularity and practical benefits of these publications. Mr. Scott laid special emphasis on personal contact of the station worker and the farmer as a means of inducing the latter to apply the information gained by scientific research to the improvement of agricultural methods and products. He outlined a plan about to be put into execution by the

New Jersey Station for sending lecturers throughout the State to address the farmers at meetings of their various organizations.

Another topic was presented by Prof. Morrow, of the Illinois College and Station, in a paper on the relations which should exist between the investigator and the teacher. In his opinion these two classes of workers might do each other and the cause of agricultural science a great service by cultivating relations of mutual helpfulness. The teacher should know what is going on in the laboratory and field, so that he might be able to bring to his pupils new truths or fresh illustrations of old ones. The investigator, on the other hand, needed to know the difficulties and questionings which presented themselves in the class room with reference to the problems he was investigating. By this means he would be better able to learn how to state processes and results of his researches so as to make his reports clear and satisfactory.

The report of the executive committee, covering a period of nine months, ending August 12, 1891, was submitted by its chairman, President Alvord, of Maryland.

The report of the section on botany, presented by Prof. Halsted, of New Jersey, showed that the station botanists had been especially active in studies on the diseases of plants and their prevention, and that results of much practical importance had followed their investigations.

In the report of the section on chemistry, presented by Director Neale, of Delaware, the work of the station chemists was classified under the following heads. (1) Detective duty; (2) agricultural manufactories; (3) work of immediate value in directing farm management; (4) development of analytical methods and invention of apparatus; (5) investigations of interest chiefly to students and scientists. The report also urged the desirability of coöperation among the workers in different branches of agricultural science, in order that the practical ends which are the real object of experiment station work might be most speedily and effectually attained.

The question, What coöperation is desirable between the colleges and stations and the Weather Bureau of the Department of Agriculture? was discussed by Assistant Secretary Willits and others. Communications from Prof. M. W. Harrington and Maj. H. H. C. Dunwoody, of the Weather Bureau, were read in this connection. As the outcome of this discussion a committee, consisting of Messrs. Smith, of Minnesota; Harris, of this office, and Alvord, of Maryland, was appointed to consider the whole subject. This committee subsequently reported the following resolutions, which were adopted:

Resolved, That in the future development and extension of the Weather Bureau in the special interests of agriculture, the Bureau should organize and assist in maintaining a study of climatology in its relations to farming, in coöperation with agricultural colleges and stations; and that the sphere of this work should be enlarged to include the physics, conditions, and changes of agricultural soils.

Resolved, That a special committee be appointed by this association to confer with the officials of the Department of Agriculture in furthering the object stated and in bringing the same to the attention of Congress.

Messrs. Alvord, Harris, and Henry, of Wisconsin, were appointed as the special committee called for by this resolution.

Hon. William T. Harris, United States Commissioner of Education, addressed the convention regarding reports by the colleges and stations to the Bureau of Education under the act of Congress of 1890. He was requested to prepare and forward to the colleges and stations blank forms for these reports. A letter was received from Hon. Justin S. Morrill expressing his appreciation of the vote of thanks passed by the

association at its last convention for the services rendered by him in securing legislation relative to the colleges.

The following resolutions, among others, were agreed to:

Resolved, That a committee of three, especially representing the colleges of agriculture and mechanic arts, be appointed to consider the subject of a collective agricultural college exhibit in the agricultural building of the World's Columbian Exposition, and with power to represent the interests of the association in this connection.

Resolved, That this association renew its expression of sincere thanks to Sir John Bennet Lawes for his munificent provision for a course of lectures on the work done at Rothamsted, to be delivered biennially in the United States, and that it also wishes to express its sincere thanks to Mr. R. Warington for consenting to deliver the first series of lectures, and its appreciation of the high scientific and practical value of the course delivered at this meeting.

It was decided that no adjourned session of the convention should be held during the present year.

The following were elected officers of the association for the ensuing year: President, W. L. Broun, of Alabama; vice-presidents, C. W. Dabney, jr., of Tennessee; J. W. Nicholson, of Louisiana; H. E. Stockbridge, of North Dakota; F. E. Emery, of North Carolina; and W. H. Jordan, of Maine; secretary and treasurer, M. A. Scovell, of Kentucky; executive committee, H. E. Alvord, of Maryland; H. H. Goodell, of Massachusetts; J. A. Myers, of West Virginia; W. Frear, of Pennsylvania; and A. T. Neale, of Delaware.

Section on agriculture: Chairman, C. L. Ingersoll, of Nebraska; vice chairman, G. W. Curtis, of Texas; secretary, T. F. Hunt, of Pennsylvania. Section on botany: Chairman, G. F. Atkinson, of Alabama; secretary, L. H. Pammel, of Iowa. Section on chemistry: Chairman, M. A. Scovell, of Kentucky; secretary, H. H. Harrington, of Texas. Section on college work. Chairman, E. M. Turner, of West Virginia; vice chairman, C. H. Pettee, of New Hampshire; secretary, H. E. Stockbridge, of North Dakota. Section on entomology: Chairman, L. Bruner, of Nebraska; secretary, F. M. Webster, of Ohio. Section on horticulture: Chairman, E. A. Popenoe, of Kansas; secretary, T. L. Brunk, of Maryland.

STATISTICS OF THE STATIONS.

Agricultural experiment stations are now in operation under the act of Congress approved March 2, 1887, in all the States and Territories except Idaho, Montana, and Alaska. In several States the United States grant is divided, so that 49 stations in 46 States and Territories are receiving money from the United States Treasury. In each of the States of Connecticut, Massachusetts, New Jersey, and New York a separate station is maintained entirely or in part by State funds, and in Louisiana a station for sugar experiments is maintained mainly by funds contributed by sugar-planters. In several States branch or substations have been established. If these be excluded the number of stations in the United States is 55. During the past year 3 new stations have been established, viz, in Washington, Wyoming, and Oklahoma. The stations with this office received during 1891 about $925,000, of which $682,500 was appropriated from the National Treasury, the rest coming from State governments, private individuals, fees for analyses of fertilizers, sales of farm products, and other sources. The stations employ 481 persons in the work of administration and inquiry. The number of officers engaged in the different lines of work is as follows: Directors, 71; chemists, 114; agriculturists, 47; horticulturists, 50; botanists, 39; entomologists, 35; veterinarians, 24; meteorologists, 14; biologists, 4; viticulturist, 1; physicists, 4; geologists, 2; mycologists, 3; microscopists, 2; irrigation engineers, 3; in charge of substations, 27; secretaries and treasurers, 27; librarians, 6; clerks, 21. There are also 61 persons classified under the head of miscellaneous,

including superintendents of gardens, grounds, and buildings, foremen of farms and gardens, apiarists, herdsmen, etc.

During 1891 the stations have published 51 annual reports and 255 bulletins. The mailing lists of the stations now aggregate about 350,000 names. At a low estimate a total of 40,000,000 pages, containing information on agricultural topics, have been disseminated among the people during the past year; furthermore, the results and processes of experiments are described in thousands of newspapers and other periodicals. The mailing listss of the stations have largely increased during the year. The calls upon station officers to make public addresses are numerous and increasing. The station correspondence with farmers is now very large, and touches on nearly every topic connected with farm theory and practice. A number of stations have made exhibits of the processes or results of their investigations at the State and county fairs. There have been many evidences of public approval of the stations and their work, as indicated by acts of the State legislatures in their behalf and gifts of money by local communities, agricultural associations, and private individuals, and by commendations of their work in the agricultural journals as well as by farmers. The relatively large space given to reports of work of the stations in the agricultural press is also an indication of the increasing favor in which the work of the stations is held.

Numerous changes have been made in the officers of the stations during the year. Under present conditions it is inevitable that changes should often occur. A large number of stations have been brought into existence at one time under conditions little known even to local managers. It must be expected that some time will pass before the right men find the right places. There are already evident advantages arising out of transfer of men from one station to another. It is hoped, however, that as the lines of work which each station may most advantageously undertake become more clearly defined and the advantages of coöperation and of division of labor are better understood, the demands of the work in particular localities and the necessity for restricting the investigations of individual stations to a limited number of problems will tend to develop specialists and to make the tenure of their office much more permanent.

Only the changes in the directorship can be noted here. In Arkansas A. E. Menke, D. SC., was succeeded by C. D. Smith, M. S., who in turn has been followed by R. L. Bennett, B. S. In Colorado, F. J. Annis, M. S., has taken the place of C. L. Ingersoll, M. S., who has become professor of agriculture in the University of Nebraska and agriculturist of the experiment station connected with that institution. G. E. Morrow, M. A., has been elected president of the board of direction of the Illinois Station in place of S. H. Peabody, LL. D., now chief of the department of liberal arts of the World's Columbian Exposition. C. S. Plumb, B. S., formerly acting director of the Indiana Station, has become director. In Iowa, James Wilson has succeeded R. P. Speer. C. D. Smith, M. S., has become director of the Minnesota Station in place of N. W. McLain, LL. B. J. C. Neal, M. D., botanist and entomologist of the Florida Station, has been made director of the Oklahoma Station. J. M. McBryde, LL. D., formerly president of the University of South Carolina and director of the experiment station until recently connected with that institution, has become president of the Agricultural and Mechanical College of Virginia, and succeeds W. D. Saunders as director of the Virginia Station.

STATIONS RECENTLY ESTABLISHED.

Since the preparation of the last annual report three new stations have been organized, viz, in Wyoming, Washington, and Oklahoma. The Wyoming Agricultural Experiment Station was organized as a department of the University of Wyoming, in accordance with an act of the State legislature approved January 10, 1891, and is located at Laramie. The station is under the control of the board of trustees of the university, which consists of eleven members, including the governor of the State, the State superintendent of education, and the president of the university as members *ex officio*. A. A. Johnson, D. D., is president of the university, and Dice McLaren, M. S., is director and agriculturist of the station. The other members of the station staff are J. D. Conley, PH. D., geologist and chemist; A. Nelson, M. S., botanist; B. C. Buffum, B. S., horticulturist; F. J. Niswander, B. S., entomologist; E. E. Slosson, B. S., assistant chemist; and Grace R. Hebard, M. A., secretary.

In order that the possibilities of agriculture in all parts and altitudes of Wyoming may be fairly tested, the trustees have established experiment farms in various portions of the State. The west-central portion and the altitude of 5,500 feet above the sea level is represented by the Lander experiment farm of 137 acres, under irrigation, in Fremont County, donated by its citizens. The Laramie Plains and the altitude of 7,000 feet is represented by the Wyoming University experiment farm of 640 acres, in Albany County, irrigated from the Pioneer Canal and granted by the Wyoming Central Land and Improvement Company. The North Platte Valley and the altitude of 6,000 feet is represented by the Saratoga experiment farm of 40 acres, under the Hugus-Mullison-Beale Ditch and the Davis-Folsom Canal, in Carbon County, donated by the Saratoga Improvement Company and the Saratoga Land and Irrigation Company. The northern part of the State and the altitude of 4,000 feet is represented by the Sheridan experiment farm of 50 acres, under irrigation, in Sheridan County, donated by its citizens. Northeastern Wyoming, with the greatest rainfall and an altitude of 4,500 feet, is represented by the Sundance experiment farm of 49 acres, to be carried on without irrigation, in Crook County, donated by its citizens. Southeastern Wyoming, the Sybille Valley, and the altitude of 5,000 feet is represented by the Wheatland experiment farm, under Ditch No. 2 of the Wyoming Development Company, in Laramie County, being donated by that company.

Experiments in irrigation and with grasses and forage plants will be special features of the work of this station.

The Agricultural Experiment Station of Oklahoma has been established as a department of the Agricultural and Mechanical College of Oklahoma, and is located at Stillwater, Payne County. The board of directors was organized June 23, 1891, and includes the governor of the Territory *ex officio*, and five other members. J. C. Neal, M. D., formerly of the Florida Station, has been elected director. A. C. Magruder, B. S., formerly of the West Virginia Station, has been elected agriculturist and horticulturist. Two hundred and forty acres of land have been donated for the college and station, and the town of Stillwater has bonded itself for $10,000 for buildings.

The Washington Agricultural Experiment Station has been organized as a department of the Agricultural College and School of Science of Washington, and is located at Pullman. George Lilley, PH. D., LL. D., has been elected director of the station, and it is expected that other officers will be chosen in time to begin experimental work during the next season.

LIST OF PUBLICATIONS OF THE OFFICE OF EXPERIMENT STATIONS.

The following publications of this office are intended for general distribution. Others which were printed for special use and are not of permanent importance, are not mentioned here:

Farmers' bulletins:

No. 1.—The What and Why of Agricultural Experiment Stations; issued June, 1889, pp. 16.

No. 2.—The Work of the Agricultural Experiment Stations—Better Cows, Fibrin in Milk, Bacteria in Milk, Silos and Silage, Alfalfa, Field Experiments with Fertilizers; issued June, 1890, pp. 16.

Experiment station bulletins:

No. 1.—Organization of the Agricultural Experiment Stations in the United States; issued February, 1889, pp. 82.

No. 2.—Digest of Annual Reports of Stations in the United States for 1888, part I, issued June, 1889, pp. 258; part II, issued May, 1891, pp. 173.

No. 3.—Report of Meeting of Horticulturists at Columbus, Ohio; issued July, 1889, pp. 12.

No. 4.—List of Horticulturists of the Agricultural Experiment Stations in the United States; issued November, 1889, pp. 27.

No. 5.—Organization List of the Agricultural Experiment Stations and Agricultural Schools and Colleges in the United States; issued March, 1890, pp. 67.

No. 6.—List of Botanists of the Agricultural Experiment Stations in the United States, with an Outline of the Work in Botany at the Several Stations; issued May, 1890, pp. 23.

Miscellaneous bulletins:

No. 1.—Proceedings of Association of American Agricultural Colleges and Experiment Stations at Knoxville, Tennessee, January, 1889; issued March, 1889, pp. 123.

No. 2.—Proceedings of Association of American Agricultural Colleges and Experiment Stations at Washington, D. C., November, 1889, pp. 142.

No. 3.—Proceedings of Association of American Agricultural Colleges and Experiment Stations at Champaign, Ill., November, 1890, pp. 156.

Circulars:

No. 7.—Coöperative Field Experiments with Fertilizers; issued March, 1889. This contains the report of the conference of representatives of stations regarding coöperative field experiments with fertilizers, directions and explanations for soil tests with fertilizers, and suggestions for further experiments, pp. 39.

No. 8.—Explanations and Directions for Soil Tests with Fertilizers; issued March, 1889. This is intended for the use of farmers experimenting under the direction of the stations. It is included in Circular No. 7, but was also printed separately for convenience, pp. 11.

No. 11.—Rules for Naming Vegetables—Report of Committee of Experiment Station Horticulturists; issued September, 1889, pp. 3.

No. 20.—Organization List of the Agricultural Experiment Stations in the United States, pp. 21.

Experiment Station Record:

Vol. I, 6 numbers, with index, pp. 358; vol. II, 12 numbers, with index, pp. 885; vol. III, 5 numbers, issued in 1891, pp. 364.

LIST OF AGRICULTURAL SCHOOLS AND COLLEGES IN THE UNITED STATES.

ALABAMA.—*Auburn:* Agricultural and Mechanical College, Alabama Polytechnic Institute; president, William LeRoy Broun, LL. D. *Abbeville:* Southeast Alabama Agricultural School; principal, J. S. Espy, M. A. *Athens:* North Alabama Agricultural School; principal, C. L. Newman, B. S. *Huntsville:* State Normal and Industrial School; principal, W. H. Councill.

ARIZONA.—*Tucson:* University of Arizona; president, Merrill P. Freeman.

ARKANSAS.—*Fayetteville:* Arkansas Industrial University; president, Edward Hunter Murfee, LL. D. *Pine Bluff:* Branch Normal College; principal, J. C. Corbin, M. A.

CALIFORNIA.—*Berkeley:* College of Agriculture of the University of California; acting president, Martin Kellogg, M. A.; dean, Irving Stringham, PH. D.

COLORADO.—*Fort Collins:* State Agricultural College of Colorado; acting president, J. W. Lawrence.

CONNECTICUT.—*Mansfield* (post office, Storrs): Storrs Agricultural School; principal, B. F. Koons, PH. D. *New Haven:* Sheffield Scientific School of Yale University; president, Timothy Dwight, D. D., LL. D.; director, George J. Brush, LL. D.

DELAWARE.—*Newark:* Delaware College; president, Albert N. Raub, PH. D.

FLORIDA.—*Lake City:* Florida State Agricultural and Mechanical College; president, Frank L. Kern, M. A. *Tallahassee:* State Normal School; president, T. DeS. Tucker, M. A.

GEORGIA.—*Athens:* Georgia State College of Agriculture and Mechanic Arts; president, H. C. White, PH. D. *Cuthbert:* Southwest Georgia Agricultural College; president, A. J. Clark. *Dahlonega:* North Georgia Agricultural College; president, William S. Basinger, M. A. *Milledgeville:* Middle Georgia Military and Agricultural College; president, J. Colton Lynes, PH. D. *Thomasville:* South Georgia College; president, G. M. Lovejoy. *Hamilton:* West Georgia Agricultural and Mechanical College; president, H. A. Hayes, B. A.

ILLINOIS.—*Urbana:* College of Agriculture of the University of Illinois; acting regent, T. J. Burrill, PH. D.; dean, George E. Morrow, M. A.

INDIANA.—*La Fayette:* School of Agriculture, Horticulture, and Veterinary Science of Purdue University; president, James H. Smart, LL. D.

IOWA.—*Ames:* Iowa State College of Agriculture and Mechanic Arts; president, W. M. Beardshear, M. A.

KANSAS.—*Manhattan:* Kansas State Agricultural College; president, George T. Fairchild, M. A.

KENTUCKY.—*Lexington:* Agricultural and Mechanical College of Kentucky; president, James K. Patterson, PH. D. *Frankfort:* State Normal School; principal, J. H. Jackson, M. A.

LOUISIANA.—*Baton Rouge:* Louisiana State University and Agricultural and Mechanical College; president, J. W. Nicholson, M. A. *New Orleans:* Southern University; president, H. A. Hill.

MAINE.—*Orono:* Maine State College of Agriculture and the Mechanic Arts; president, Merritt C. Fernald, PH. D.

MARYLAND.—*College Park:* Maryland Agricultural College; president, Henry E. Alvord, C. E.

MASSACHUSETTS.—*Amherst:* Massachusetts Agricultural College; president, Henry H. Goodell, M. A., LL. D. *Jamaica Plain:* Bussey Institution of Harvard University; president, Charles W. Eliot, LL. D.; dean, F. H. Storer, B. S.

MICHIGAN.—*Agricultural College:* Michigan Agricultural College; president, Oscar Clute, M. S.

MINNESOTA.—*St. Anthony Park:* College of Agriculture of the University of Minnesota; president, Cyrus Northrop, LL. D. State School of Agriculture of the University of Minnesota; principal, W. W. Pendergast.

MISSISSIPPI.—*Agricultural College:* Agricultural and Mechanical College of Mississippi; president, S. D. Lee. *Rodney:* Alcorn Agricultural and Mechanical College; president, John H. Burrus, M. A.

MISSOURI.—*Columbia:* College of Agriculture of the University of the State of Missouri; president, Richard H. Jesse; dean, Edward D. Porter, PH. D. *Jefferson City:* Lincoln Institute; principal, Inman E. Page, M. A.

NEBRASKA.—*Lincoln:* Industrial College of the University of Nebraska; chancellor, J. H. Canfield, M. A.; dean, C. L. Ingersoll, M. S.

NEVADA.—*Reno:* School of Agriculture of the Nevada State University; president, Stephen A. Jones, PH. D.

NEW HAMPSHIRE.—*Hanover:* New Hampshire College of Agriculture and the Mechanic Arts (in connection with Dartmouth College); president, Samuel C. Bartlett, D. D., LL. D.; dean, Charles H. Pettee, M. A., C. E.

NEW JERSEY.—*New Brunswick:* Rutgers Scientific School of Rutgers College; president, Austin Scott, PH. D., LL. D.
NEW MEXICO.—*Las Cruces:* Agricultural College of New Mexico; president, Hiram Hadley, M. A.
NEW YORK.—*Ithaca:* College of Agriculture of Cornell University; president, Charles Kendall Adams, LL. D.; dean, Isaac Phillips Roberts, M. AGR.
NORTH CAROLINA.—*Raleigh:* The North Carolina College of Agriculture and Mechanic Arts; president, Alexander Q. Holladay. *Raleigh:* Shaw University; president, H. M. Tupper, M. A., D. D.
NORTH DAKOTA.—*Fargo:* North Dakota Agricultural College; president, H. E. Stockbridge, PH. D.
OHIO.—*Columbus:* Ohio State University; president, William H. Scott, LL. D.
OKLAHOMA.—*Stillwater:* Oklahoma Agricultural and Mechanical College; president, R. J. Barker; dean, J. C. Neal, PH. C., M. D.
OREGON.—*Corvallis:* Oregon State Agricultural College; president, B. L. Arnold, M. A.
PENNSYLVANIA.—*State College:* The Pennsylvania State College; president, George W. Atherton, LL. D.
RHODE ISLAND.—*Kingston:* Rhode Island State Agricultural School; president, John H. Washburn, PH. D. *Providence:* Agricultural and Scientific Department of Brown University; president, Elisha Benjamin Andrews, D. D., LL. D.
SOUTH CAROLINA.—*Fort Hill:* Clemson Agricultural College; president, H. A. Strode. *Orangeburgh:* Claflin University, College of Agriculture and Mechanics' Institute; president, L. M. Dunton, D. D.
SOUTH DAKOTA.—*Brookings:* South Dakota Agricultural College; president, Lewis McLouth, PH. D.
TENNESSEE.—*Knoxville:* State Agricultural and Mechanical College of the University of Tennessee; president, Charles W. Dabney, jr., PH. D., LL. D.; dean, Thomas W. Jordan, M. A.
TEXAS.—*College Station:* State Agricultural and Mechanical College of Texas; president, L. S. Ross. *Hempstead:* Prairie View Normal School; principal, L. C. Anderson, M. A.
UTAH.—*Logan:* Agricultural College of Utah; president, J. W. Sanborn, B. S.
VERMONT.—*Burlington:* University of Vermont and State Agricultural College; president, Matthew H. Buckham, D. D.
VIRGINIA.—*Blacksburg:* Virginia Agricultural and Mechanical College; president, J. M. McBryde, PH. D., LL. D. *Hampton:* Hampton Normal Institute; president, Samuel C. Armstrong, LL. D.
WASHINGTON.—*Pullman:* Washington Agricultural and Mechanical College; president, George Lilley, PH. D., LL. D.
WEST VIRGINIA.—*Morgantown:* West Virginia University; president, E. M. Turner, LL. D. *Kanawha City:* West Virginia Institute.
WISCONSIN.—*Madison:* College of Agriculture of the University of Wisconsin; president, T. C. Chamberlin, PH. D., LL. D.
WYOMING.—*Laramie:* College of Agriculture of the University of Wyoming; president, A. A. Johnson, M. A., D. D.

The legal names, locations, and directors of the agricultural experiment stations in the United States.

State.	Name of station.	Location.	Director.
Alabama	Agricultural Experiment Station of the Agricultural and Mechanical College of Alabama.	Auburn	W. L. Broun, LL. D. *a*
	Canebrake Agricultural Experiment Station.	Uniontown	W. H. Newman, M. S. *b*
	North Alabama Branch Agricultural Experiment Station.	Athens	R. E. Binford, M. A.
	Southeast Alabama Agricultural Experiment Station.	Abbeville	D. Gillis, M. S.
Arizona	Agricultural Experiment Station of the University of Arizona.	Tucson	F. A. Gulley, M. S.
Arkansas	Arkansas Agricultural Experiment Station. (Substations at Newport and Pine Bluff.)	Fayetteville	R. L. Bennett, B. S.
California	Agricultural Experiment Station of the University of California. (Substations at Cupertino, Fresno, Glen Ellen, Jackson, Mission San José, Paso Robles, Pomona, and Tulare.)	Berkeley	E. W. Hilgard, PH. D. LL. D.
Colorado	Agricultural Experiment Station. (Substations at Del Norte and Rocky Ford.)	Fort Collins	Walter J. Quick, B. S.
Connecticut	The Connecticut Agricultural Experiment Station.	New Haven	S. W. Johnson, M. A.
	Storrs School Agricultural Experiment Station.	Storrs	W. O. Atwater, PH. D.
Delaware	The Delaware College Agricultural Experiment Station.	Newark	A. T. Neale, PH. D.
Florida	Agricultural Experiment Station of Florida. (Substations at De Funiak Springs and Fort Myers.)	Lake City	J. P. DePass.
Georgia	Georgia Experiment Station	Experiment *c*	R. J. Redding.
Illinois	Agricultural Experiment Station of the University of Illinois.	Champaign	G. E. Morrow, M. A. *a*
Indiana	Purdue University Agricultural Experiment Station.	La Fayette	C. S. Plumb, B. S.
Iowa	Iowa Agricultural Experiment Station.	Ames	James Wilson.
Kansas	Kansas Agricultural Experiment Station.	Manhattan	G. T. Fairchild, M. A. *d*
Kentucky	Kentucky Agricultural Experiment Station.	Lexington	M. A. Scovell, M. S.
Louisiana	No. 1. Sugar Experiment Station	Audubon Park, New Orleans.	W. C. Stubbs, PH. D.
	No. 2. State Experiment Station	Baton Rouge	W. C. Stubbs, PH. D.
	No. 3. North Louisiana Experiment Station.	Calhoun	W. C. Stubbs, PH. D.
Maine	Maine State College Agricultural Experiment Station.	Orono	W. H. Jordan, M. S.
Maryland	Maryland Agricultural Experiment Station.	College Park	H. E. Alvord, C. E.
Massachusetts	Massachusetts State Agricultural Experiment Station.	Amherst	C. A. Goessmann, PH. D., LL. D.
	Hatch Experiment Station of the Massachusetts Agricultural College.	Amherst	H. H. Goodell, LL. D.
Michigan	Experiment Station of Michigan Agricultural College.	Agricultural College.	O. Clute, M. S.
Minnesota	Agricultural Experiment Station of the University of Minnesota.	St. Anthony Park	C. D. Smith, M. S.
Mississippi	Mississippi Agricultural Experiment Station.	Agricultural College.	S. M. Tracy, M. S.
Missouri	Missouri Agricultural College Experiment Station.	Columbia	E. D. Porter, PH. D.
Nebraska	Agricultural Experiment Station of the University of Nebraska.	Lincoln	H. H. Nicholson, M. A.
Nevada	Nevada Agricultural Experiment Station.	Reno	S. A. Jones, PH. D.
New Hampshire	New Hampshire Agricultural Experiment Station.	Hanover	G. H. Whitcher, B. S.
New Jersey	New Jersey State Agricultural Experiment Station.	New Brunswick	J. Neilson. *e*
	New Jersey Agricultural College Experiment Station.	New Brunswick	J. Neilson. *e*
New Mexico	Agricultural Experiment Station of New Mexico.	Las Cruces	H. Hadley, M. A.

a President of board of direction.
b Assistant director in charge.
c Freight and express office, Griffin.
d Chairman of council.
e Acting director.

The legal names, locations, and directors of the agricultural experiment stations, etc.—Cont'd.

State.	Name of station.	Location.	Director.
New York	New York Agricultural Experiment Station.	Geneva	P. Collier, PH. D.
	Cornell University Agricultural Experiment Station.	Ithaca	I. P. Roberts, M. AGR.
North Carolina	North Carolina Agricultural Experiment Station.	Raleigh	H. B. Battle, PH. D.
North Dakota	North Dakota Agricultural Experiment Station.	Fargo	H. E. Stockbridge, PH D.
Ohio	Ohio Agricultural Experiment Station.	Columbus	C. E. Thorne.
Oklahoma	Oklahoma Agricultural Experiment Station.	Stillwater	J. C. Neal, M. D.
Oregon	Oregon Experiment Station	Corvallis	B. L. Arnold, M. A.
Pennsylvania	The Pennsylvania State College Agricultural Experiment Station.	State College	H. P. Armsby, PH. D.
Rhode Island	Rhode Island State Agricultural Experiment Station.	Kingston	C. O. Flagg, B. S.
South Carolina	South Carolina Agricultural Experiment Station.	Fort Hill	H. A. Strode.
South Dakota	South Dakota Agricultural Experiment Station.	Brookings	L. Foster, M. S. A.
Tennessee	Agricultural Experiment Station of the University of Tennessee.	Knoxville	F. Lamson-Scribner, B.S.
Texas	Texas Agricultural Experiment Station.	College Station	G. W. Curtis, M. S. A.
Utah	Agricultural Experiment Station of Utah.	Logan	J. W. Sanborn, B. S.
Vermont	State Agricultural Experiment Station.	Burlington	W. W. Cooke, M. A.
Virginia	Virginia Agricultural and Mechanical College Experiment Station.	Blacksburg	J. M. McBryde, LL. D.
Washington	Washington Agricultural Experiment Station.	Pullman	George Lilley, LL. D.
West Virginia	West Virginia Agricultural Experiment Station.	Morgantown	J. A. Myers, PH. D.
Wisconsin	Agricultural Experiment Station of the University of Wisconsin.	Madison	W. A. Henry, B. AGR.
Wyoming	Wyoming Agricultural Experiment Station.	Laramie	Dice McLaren, M. S.

Table showing the total number of members in the working staffs of experiment stations in the United States and the number of such officers pursuing different specialties.

NOTE.—A capital letter signifies that one of the number which it follows represents an officer who having two titles and belonging by his first title in the column for which the letter stands, has already been entered there. Thus the entry 1 H under entomologists and opposite Florida means that one officer is known as "botanist and entomologist," and has already been entered by his first title in the H or botanists' column. Two letters indicate that two of the preceding number have been entered elsewhere.

Stations.	Number in staff.	A	B	C	D	E	F	G	H	I	K	L	M	N	O	P	Q	R	S	T	U
		Directors.	Secretaries and treasurers.	Librarians.	Clerks.	In charge of substations.	Agriculturists.	Biologists.	Botanists.	Chemists.	Entomologists.	Geologists.	Horticulturists.	Irrigation engineers.	Meteorologists.	Microscopists.	Mycologists.	Physicists.	Veterinarians.	Viticulturists.	Miscellaneous.
Alabama (College)	10	1					2	1	1	4					1 H				1		
Alabama (Canebrake)	4	2	1																1		
Alabama (North)	3	1	2																		
Alabama (Southeast)	3	1	1																		*a* 1
Arizona	9	1				1			1	2	1 H		2	1 O	1						*b* 1
Arkansas	7	1				2				2			1						1		
California	23	1			1	*c* 11	1		1	4 A L	1	1								1	*d* 3
Colorado	14	1	1		1	3	2 A		1	1	1		2 H	2 O	2						
Connecticut (State)	12	2		1	1 C					5 A							1				*e* 4
Connecticut (Storrs)	5	2					2			2 A											
Delaware	5	1							1	1	1 M		1		1						
Florida	8	1				2			1	2	1 H		1						1		
Georgia	5	2	1 M				1			2 A			1		1 I						*f* 1 F
Illinois	10	1	1				2 A		2 M	2	1		2						1		
Indiana	8	1					1		2	2			1						1		
Iowa	13	2	2				1		1	2	2		1						2		
Kansas	13	1	1				2		2	2	2 M		2						1		*g* 2 M
Kentucky	9	1			1		1		2 K K	3 A	2		1						1		
Louisiana (Sugar)	7	1	1							2											*h* 3
Louisiana (State)	10	2	2						1	2	1		1 K						1		*i* 1
Louisiana (North)	5	2								1											*j* 2
Maine	11	1			1		1		2	2	2 H H		1		1				1		*k* 1
Maryland	7	1			1		1			1			1					1			*l* 1
Massachusetts (State)	9	1								6 A							1				*m* 2
Massachusetts (Hatch)	9	1	1				2				1		2		1						*n* 1
Michigan	16	1	1	1			2	2	2	3			2						1		*o* 1
Minnesota	5	1	1						1 K	1	1		1								
Mississippi	13	2	1			3	1		1	2	1		1						1		
Missouri	9	1	2				1			2	1 M		1						1		*k* 1
Nebraska	13	1	1				2		1	3 A	1		1					2	1		*k* 1

Nevada	6	1		1			1		1 K	1	1		1 F								*k* 1
New Hampshire	10	1			1					2	1				1	1					*p* 3
New Jersey (State)	6	1			1					3											*q* 1
New Jersey (College)	9	1		1	2 C			1	1	2	1		1 H								*k* 1
New Mexico	5	1					1 M		1	1 H	1		1		1						
New York (State)	12	2			1		1			6			2								
New York (Cornell)	13	2	2 A				2 A		2	2	2		2						1		*r* 1 H
North Carolina	12	1	1				1		1	5 A	1 H		2		2						
North Dakota	9	1					1		1	2			1						1		*s* 2
Ohio	7	2			1		1		1				1 A		1						*t* 1
Oklahoma	2	1					1						1 F								
Oregon	6	1					1			1	1		1								*u* 1
Pennsylvania	12	2			1		1		1	5 A			1								*g* 2
Rhode Island	9	1			1		2 A			2			1						1		*v* 2
South Carolina	6	3					1 A			3											
South Dakota	12	1		1	2		1 A		1	2	2		1								*w* 2
Tennessee	7	2		1	1 C		1		1 A	2			1								
Texas	7	1					2 A			3 O					1				1		*o* 1
Utah	6	1	1		1					1	1 M		1								*k* 1
Vermont	9	1	1		1				1	2	1		1						1		
Virginia	9	2	1				1		1	2	*x* 1 A		*x* 2 A				*x* 1 A		1		
Washington	5	1					1		1 M	1			1						1		
West Virginia	6	1			1		1		1	1	1					1 H					
Wisconsin	9	1			1					2			1					1	1		*w* 2
Wyoming	12	1	1			5	1 A		1	2 L	1	1	1								
Office of Experiment Stations	14																				14
Total	495	71	27	6	21	27	47	4	39	114	35	2	50	3	14	2	3	4	24	1	61

a Foreman.
b Engineer.
c Seven patrons and 4 foremen of substations.
d One foreman of station grounds, 1 foreman of cellars, and 1 inspector of stations.
e One grass agent, 1 superintendent of buildings and grounds, and 2 laboratory assistants.
f Dairyman.
g One foreman of farm and 1 foreman of gardens.
h One sugar-maker, 1 machinist, and 1 farm manager.
i Farm manager.
j One farm manager and 1 man in charge of stock.
k Foreman of farm.
l Machinist.
m One superintendent of field experiments and stock-feeding and 1 farmer.
n Auditor.
o Assistant to director.
p One dairyman, 1 farmer, and 1 general assistant.
q Laboratory assistant and janitor.
r Arboriculturist.
s One farm superintendent and 1 arboriculturist.
t Foreman of gardens.
u Superintendent of agricultural department.
v One apiarist and poultry manager and 1 farmer.
w One dairyman and 1 farmer.
x The vice-director is also mycologist, entomologist, and horticulturist.

The lines of work pursued

[The ○ indicates

	Stations.	Chemistry.		Systematic and physiological botany.	Meteorology and climatology.	Soil.		Fertilizers.			Crops.				Horticulture.				
		Special analyses.	Methods of analysis.			Geology, physics, and chemistry.	Tillage.	Analyses without control.	Analyses with control.	Field experiments.	Composition.	Manuring and cultivation.	Rotation.	Varieties.	Vegetables.	Small fruits.	Grapes.	Orchard fruits.	Nuts.
1	Alabama (College)	⊙	...	⊙	⊙	⊙	○	...	○	○	...	○	○	○	○	○	○	○	...
2	Alabama (Canebrake)	...	...	...	...	⊙	⊙	⊙	⊙	○	⊙	○	○	○	⊙	⊙	⊙	⊙	...
3	Alabama (North)	⊙	...	...	⊙	⊙	○	...	...	○	...	⊙	⊙	○	⊙	○	⊙	○	...
4	Alabama (Southeast)	⊙	...	...	○	...	⊙	...	...	○	...	○	○	○	⊙	○	○	○	⊙
5	Arizona	○	...	⊙	⊙	⊙	⊙	...	...	...	...	...	...	...	...	⊙	○	○	⊙
6	Arkansas	○	⊙	...	○	○	○	⊙	...	○	○	○	○	○	○	○	○	○	○
7	California	⊙	...	⊙	⊙	○	⊙	⊙	...	⊙	○	⊙	...	⊙	⊙	⊙	○	○	⊙
8	Colorado	⊙	⊙	○	○	⊙	⊙	⊙	⊙	⊙	⊙	○	○	○	○	○	⊙	⊙	⊙
9	Connecticut (State)	○	⊙	...	...	⊙	...	...	○	⊙	...	...	...	...	...	...	...	...	...
10	Connecticut (Storrs)	⊙	⊙	...	...	...	...	...	...	⊙	⊙	...	...	...	...	...	...	...	...
11	Delaware	⊙	⊙	⊙	⊙	...	⊙	...	...	○	⊙	○	○	⊙	○	○	○	○	...
12	Florida	○	...	⊙	⊙	...	...	...	...	○	○	○	⊙	○	○	⊙	○	○	...
13	Georgia	⊙	...	...	⊙	...	○	...	...	○	...	○	○	○	○	○	○	○	⊙
14	Illinois	○	○	...	⊙	⊙	○	⊙	...	○	○	○	○	○	⊙	○	○	○	...
15	Indiana	⊙	⊙	...	⊙	...	○	...	...	○	⊙	○	○	○	⊙	○	⊙	○	...
16	Iowa	○	...	⊙	...	...	○	...	...	...	...	⊙	⊙	⊙	⊙	...	...	○	...
17	Kansas	⊙	⊙	⊙	⊙	...	⊙	...	...	⊙	⊙	⊙	○	○	⊙	⊙	○	⊙	...
18	Kentucky	○	○	⊙	⊙	...	⊙	...	○	○	⊙	○	...	○	○	○	...	...	...
19	Louisiana (Sugar)																		
20	Louisiana (State)	○	○	⊙	○	○	○	○	○	○	○	⊙	⊙	⊙	...	...	○	...	...
21	Louisiana (North)																		
22	Maine	⊙	○	...	⊙	...	...	...	⊙	○	⊙	⊙	...	...	○	○	⊙	○	...
23	Maryland	⊙	○	⊙	⊙	○	⊙	⊙	...	○	⊙	⊙	○	⊙	⊙	○	⊙	⊙	...
24	Massachusetts (State)	⊙	⊙	○	⊙	...	⊙	⊙	○	○	○	⊙	⊙	○	⊙	...	...	⊙	...
25	Massachusetts (Hatch)	...	...	⊙	○	...	...	...	...	○	⊙	⊙	...	⊙	⊙	○	⊙	⊙	...
26	Michigan	⊙	⊙	⊙	⊙	⊙	○	...	○	⊙	⊙	⊙	⊙	⊙	○	○	○	○	...
27	Minnesota	⊙	○	...	...	...	⊙	...	...	⊙	...	...	⊙	⊙	...	○	○	⊙	...
28	Mississippi	⊙	...	○	⊙	...	⊙	⊙	...	○	⊙	○	⊙	○	⊙	⊙	○	⊙	...
29	Missouri	○	⊙	...	⊙	...	...	○	...	...	⊙	○	○	○	○	○	○	○	○
30	Nebraska	⊙	⊙	...	○	○	○	...	...	...	⊙	⊙	⊙	⊙	⊙	⊙	⊙	○	...
31	Nevada	⊙	⊙	...	⊙	○	⊙	...	⊙	⊙	⊙	...	⊙	○	...	⊙	⊙	...	...
32	New Hampshire	⊙	⊙	...	...	...	⊙	⊙	...	○	⊙	○	⊙	⊙	...	...	...	...	...
33	New Jersey (State)	○	○	○	○	...	...	○	○	○	○	⊙	⊙	...	⊙	⊙	⊙	⊙	...
34	New Jersey (College)																		
35	New Mexico	...	...	...	⊙	...	⊙	...	...	...	...	...	⊙	⊙	⊙	⊙	⊙	⊙	⊙
36	New York (State)	...	○	...	○	...	⊙	⊙	○	○	⊙	○	...	...	○	○	○	○	...
37	New York (Cornell)	⊙	⊙	⊙	...	⊙	○	⊙	...	⊙	⊙	⊙	⊙	⊙	○	⊙	⊙	○	...
38	North Carolina	○	...	...	○	...	⊙	...	○	○	○	○	○	○	○	○	○	⊙	...
39	North Dakota	○	...	○	⊙	○	...	...	...	○	...	...	...	⊙	...	...	...	...	...
40	Ohio	⊙	...	⊙	⊙	⊙	⊙	⊙	...	○	⊙	⊙	⊙	○	⊙	○	⊙	○	...
41	Oklahoma	⊙	...	...	...	⊙	○	...	...	...	...	⊙	...	⊙	⊙	○	○	○	○
42	Oregon	⊙	...	⊙	⊙	○	...	⊙	...	...	⊙	○	...	○	○	○	⊙	○	⊙
43	Pennsylvania	⊙	⊙	...	⊙	...	...	○	...	⊙	⊙	⊙	...	⊙	⊙	⊙	⊙	⊙	⊙
44	Rhode Island	○	⊙	...	⊙	...	⊙	⊙	○	⊙	⊙	⊙	...	⊙	⊙	○	○	○	⊙
45	South Carolina	...	...	...	...	...	...	○	○	⊙	...	⊙	...	⊙	...	...	...	...	...
46	South Dakota	⊙	⊙	⊙	○	⊙	...	...	...	...	...	⊙	○	○	⊙	⊙	...	○	...
47	Tennessee	⊙	⊙	○	...	⊙	⊙	○	⊙	⊙	○	⊙	...	...	○	...	○	⊙	...
48	Texas	⊙	⊙	...	⊙	⊙	⊙	⊙	...	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙
49	Utah	⊙	...	...	⊙	⊙	⊙	...	...	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	...
50	Vermont	⊙	○	...	⊙	...	...	⊙	○	⊙	⊙	⊙	...	⊙	○	○	○	⊙	...
51	Virginia	⊙	...	...	⊙	...	...	⊙	...	⊙	...	...	...	⊙	○	⊙	○	○	⊙
52	Washington	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
53	West Virginia	⊙	⊙	○	⊙	...	...	...	○	○	⊙	⊙	...	⊙	⊙	⊙	⊙	⊙	...
54	Wisconsin	⊙	⊙	...	⊙	○	○	⊙	...	...	○	○	...	⊙	...	○	○	○	...
55	Wyoming	○	⊙	○	○	○	○	...	...	⊙	⊙	○	⊙	○	⊙	○	⊙	○	⊙
	Total	46	31	24	41	25	36	24	18	42	37	43	32	44	41	42	42	43	15

at the several stations.

specialties.]

Forestry.	Diseases of plants.	Seeds.	Weeds.	Feeding stuffs.		Silos and silage.	Feeding of animals.				Aviculture.	Veterinary science and practice.	Entomology.	Apiculture.	Dairying.				Technology—sugars, wines, etc.	Agricultural engineering.		
				Composition.	Digestibility.		For milk.	For beef.	For mutton.	For pork.					Chemistry of milk and its products.	Bacteria of milk.	Creaming of milk.	Butter-making and creameries.		Drainage.	Irrigation.	
....	....	○	....	....	....	○	....	....	....	....	....	....	⊙	....	⊙	....	....	⊙	....	○	....	1
....	....	⊙	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	⊙	....	2
....	....	....	....	....	....	....	⊙	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3
....	....	....	....	....	....	○	....	⊙	....	⊙	....	○	....	....	....	....	....	....	....	○	....	4
....	⊙	....	....	....	....	....	....	....	....	....	....	....	⊙	....	....	....	....	....	....	....	○	5
....	⊙	○	....	○	⊙	....	....	⊙	....	○	....	○	⊙	....	....	....	....	....	⊙	....	....	6
⊙	○	○	⊙	○	....	....	....	....	....	....	....	....	○	....	⊙	....	....	....	○	○	○	7
⊙	⊙	⊙	○	⊙	⊙	....	⊙	⊙	⊙	⊙	....	⊙	○	○	○	....	⊙	⊙	....	⊙	○	8
....	○	....	....	○	....	....	....	....	....	....	....	....	⊙	....	○	....	....	....	....	....	....	9
....	....	....	....	○	....	....	⊙	....	....	....	....	....	....	....	⊙	○	....	....	....	....	....	10
....	○	⊙	⊙	⊙	....	⊙	⊙	....	....	....	....	....	○	....	⊙	....	⊙	○	⊙	⊙	....	11
....	○	⊙	⊙	⊙	⊙	⊙	⊙	....	....	⊙	⊙	○	○	....	....	....	⊙	⊙	....	....	....	12
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	⊙	⊙	....	⊙	....	13
⊙	○	○	⊙	○	....	⊙	○	○	....	○	....	....	....	....	⊙	....	○	○	....	....	....	14
....	⊙	....	....	○	....	....	....	○	....	○	....	○	⊙	....	....	....	⊙	⊙	....	....	....	15
....	⊙	....	....	○	....	⊙	....	....	....	....	....	....	○	....	○	....	⊙	....	⊙	....	....	16
⊙	○	⊙	....	⊙	....	⊙	⊙	○	....	⊙	....	○	○	⊙	⊙	....	....	....	○	....	....	17
....	○	....	⊙	⊙	⊙	....	○	....	....	....	....	⊙	○	....	....	....	○	....	....	○	....	18
....	○	⊙	....	⊙	....	⊙	....	....	....	....	....	○	○	....	....	....	....	....	○	○	○	19, 20, 21
....	○	⊙	....	⊙	○	....	○	....	⊙	○	....	....	....	....	⊙	....	⊙	○	....	....	....	22
....	⊙	....	⊙	⊙	⊙	○	⊙	⊙	....	....	....	....	....	....	⊙	....	....	⊙	....	....	....	23
....	○	⊙	....	○	....	⊙	○	○	○	○	....	....	....	....	○	....	....	○	....	....	....	24
⊙	○	⊙	⊙	⊙	....	⊙	⊙	....	....	....	....	....	○	....	....	....	....	....	....	⊙	....	25
⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	....	⊙	○	○	....	....	....	....	....	⊙	....	26
⊙	....	....	....	○	....	○	○	....	⊙	⊙	....	....	○	....	○	○	○	○	....	....	....	27
....	○	....	....	⊙	⊙	⊙	○	....	....	....	....	○	○	....	....	....	....	○	....	⊙	....	28
....	○	....	....	○	○	....	⊙	○	⊙	○	....	○	....	....	⊙	....	⊙	○	○	⊙	....	29
○	○	⊙	○	....	....	....	⊙	⊙	....	⊙	⊙	....	○	....	○	⊙	....	....	○	....	....	30
⊙	⊙	⊙	⊙	⊙	....	....	....	....	....	....	....	....	○	....	○	....	....	○	....	....	....	31
....	....	....	....	○	⊙	○	○	....	....	○	....	....	⊙	....	○	⊙	○	○	....	....	....	32
....	○	⊙	○	○	⊙	....	○	....	....	....	....	....	○	....	○	....	⊙	⊙	⊙	....	....	33, 34
....	....	⊙	....	....	....	....	....	....	....	....	....	....	⊙	....	....	....	....	....	....	....	⊙	35
....	○	....	....	○	....	○	○	....	....	○	....	....	....	....	○	⊙	○	○	....	....	....	36
....	⊙	⊙	⊙	⊙	....	⊙	⊙	⊙	○	○	○	....	○	....	○	....	○	⊙	....	⊙	....	37
....	⊙	○	⊙	○	○	○	⊙	○	⊙	....	....	....	○	....	....	....	....	⊙	....	....	....	38
○	○	....	○	....	....	....	....	....	....	....	....	⊙	....	....	⊙	⊙	⊙	....	....	....	....	39
....	○	....	....	⊙	....	⊙	⊙	....	....	....	....	....	○	....	⊙	....	....	....	....	⊙	⊙	40
○	....	....	○	....	....	⊙	....	....	....	....	....	....	⊙	....	....	....	....	....	....	....	⊙	41
....	....	....	....	⊙	....	....	....	⊙	⊙	....	....	....	○	....	....	....	....	....	....	....	....	42
⊙	....	⊙	....	○	○	○	○	....	....	....	....	....	....	....	....	....	○	○	....	....	....	43
⊙	⊙	⊙	⊙	⊙	....	....	....	....	....	....	○	○	....	○	....	⊙	....	....	....	⊙	....	44
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○	⊙	....	....	○	....	....	⊙	....	....	⊙	....	⊙	○	○	....	....	⊙	○	....	....	○	46
....	○	⊙	⊙	⊙	....	⊙	○	....	....	....	....	....	....	....	⊙	....	⊙	....	....	⊙	....	47
⊙	⊙	....	....	⊙	⊙	⊙	⊙	⊙	....	⊙	....	⊙	....	....	⊙	....	○	○	⊙	○	⊙	48
⊙	....	⊙	....	⊙	⊙	⊙	....	⊙	⊙	⊙	....	....	....	....	....	....	....	....	....	⊙	⊙	49
....	○	⊙	⊙	⊙	⊙	○	○	⊙	....	○	....	⊙	⊙	⊙	○	⊙	○	○	⊙	....	....	50
....	⊙	....	....	....	....	⊙	....	....	....	....	....	....	⊙	⊙	....	....	....	....	....	....	....	51
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○	○	⊙	○	⊙	....	....	....	....	....	....	....	○	....	○	....	....	○	....	....	....	....	53
....	○	....	○	○	....	○	○	....	○	○	....	....	⊙	....	○	....	○	○	○	○	....	54
○	⊙	⊙	⊙	○	⊙	....	⊙	○	○	⊙	....	⊙	○	....	....	⊙	....	⊙	○	○	○	55
18	37	27	22	39	17	27	30	18	12	22	4	18	32	8	26	9	23	25	13	21	11	

Revenue and additions to the equipment of the agricultural experiment stations in 1891.

Stations.	Revenue for 1891 from—								Value of additions to equipment in 1891.						
	United States.	States.	Local communities.	Individuals.	Fees.	Farm produce.	Miscellaneous.	Total.	Farm.	Buildings.	Library.	Apparatus.	Live stock.	Miscellaneous.	Total.
Alabama (College)	$15,000	$8,000				$2,134		$25,134	$338		$500	$200		$250	$1,288
Alabama (Canebrake)		2,500				400		2,900	250	$100	40	20		75	485
Alabama (North)		2,500			$400			2,900			50		$175		225
Alabama (Southeast)		2,500	$400		700	325		3,925	50	100					150
Arizona	15,000						$95	15,095	277	349	28	538	798	449	2,439
Arkansas	15,000							15,000	52	650	18	290	209	184	1,403
California	15,000	8,000						23,000	445	3,650	150	150	510	1,200	6,105
Colorado	15,000		800			1,820	150	17,770	919	2,037		745	75	100	3,876
Connecticut (State)	7,500	8,000			3,070		38	18,608			295				295
Connecticut (Storrs)	7,500			$375		304		8,179	100			250	80		430
Delaware	15,000							15,000	27	750	311	297			1,385
Florida	15,000				276		224	15,500	240	750	134	292	200	50	1,666
Georgia	15,000	5,000				500	350	20,850	100	5,500		1,000	200		6,800
Illinois	15,000				90			15,090	200	280	700	800			1,980
Indiana	15,000	5,048				2,648		22,696	75		100	750			925
Iowa	15,000				11	345	3	15,359	100	75	75	100	1,600	50	2,000
Kansas	15,000							15,000			203	337		60	600
Kentucky	15,000				1,824	332	450	17,606	462	130	266	1,252	450	364	2,924
Louisiana (Sugar)															
Louisiana (State)	15,000	10,500		5,000		2,500	500	33,500	500	700	250	1,000	800	1,000	4,250
Louisiana (North)															
Maine	15,000					476		15,476		500	100	1,000			1,600
Maryland	15,000							15,000	370	748	267	56	150	150	1,741
Massachusetts (State)		10,000			1,900	1,500		13,400	150	2,000	200	475	150	100	3,075
Massachusetts (Hatch)	15,000							15,000			580	382		295	1,257
Michigan	15,000				780	967	471	17,218	54	750	246	647			1,697
Minnesota	15,000	6,000				3,329		24,329	75	15,000	50	2,500	400		18,025
Mississippi	15,000					162	622	15,784	100	1,300	150	210		400	2,160
Missouri	15,000					3,000	500	18,500	300	1,800	100		500		2,700
Nebraska	15,000							15,000	97	99	284	788		422	1,690
Nevada	15,000							15,000	223	1,270	200	1,550		850	4,093
New Hampshire	15,000					3,000		18,000	200		100	300	500		1,100
New Jersey (State)		11,000						11,000							
New Jersey (College)	15,000							15,000	540	750	746	250	200		2,486
New Mexico	15,000					40		15,040	262	750	361	1,087		2,434	4,894
New York (State)		50,000						50,000	150	15,000	150	350	2,500	2,500	20,650
New York (Cornell)	15,000					600		15,600		650	100	500		500	1,750
North Carolina	15,000	5,000				300	100	20,400	200	600	150	200	200	150	1,500
North Dakota	17,500	(*)					500	18,000		18,000	1,000	2,500		1,200	22,700
Ohio	15,000	3,200				5,818	169	24,187	740	1,982	138	1,044	452	75	4,431
Oklahoma															

Oregon	15,000							15,000	287	3,500	300	2,075	625	1,693	8,480
Pennsylvania	15,000	750			7,264	2,523		25,537							
Rhode Island	15,000					1,287		16,287	523	750	1,192	555	391	542	3,953
South Carolina	15,000	10,000				2,957		27,957	1,174	1,500	151	1,829	2,522	183	7,359
South Dakota	15,000							15,000	762	4,250		2,443	2,967		10,422
Tennessee	15,000				198			15,198	61	750	270	230	600	299	2,210
Texas	15,000					2,169		17,169	40	352	13	16		50	471
Utah	15,000					656		15,656	1,784	750	122	2,800	3,565	200	9,221
Vermont	15,000				50	1,100	50	16,200	2,500	16,000	100	300	1,600	200	20,700
Virginia	15,000					2,238		17,238							
Washington										2,500	150				2,650
West Virginia	15,000						120	15,120	98	750	168	921		131	2,068
Wisconsin	15,000	5,000				2,500	500	23,000	300	454	384	1,500	1,948	254	4,840
Wyoming	15,000							15,000	3,000	3,500	1,000	5,000	575	500	13,575
Total	662,500	152,998	1,200	5,375	16,563	45,930	4,842	889,408	18,125	111,326	11,892	39,529	24,942	16,910	222,724

* $25,000 appropriated by the State for buildings for station and college.

Synopsis of the four-years' course in agriculture in colleges in several States.

Year.	Massachusetts.	New York.	Pennsylvania.	Mississippi.	Kansas.	Michigan.	California.
I	Agric		Agric	Agric		Agric	
				Hort			
	Chem	Chem	Chem	Nat. phil			Chem.
	Min						
	Bot				Bot	Bot	
		Physiol					
		Zoöl					
		Entom					
					Arith		
	Alg	Math		Alg	Alg	Alg	Math.
	Geom					Geom	
	Lat	Fr. or Ger.	Ger	Ger			Fr. or Ger.
	Engl	Engl	Engl	Engl	Engl	Engl	Engl.
			Rhet			Rhet	
				Hist	Hist	Hist	
	Draw	Draw	Draw	Draw	Draw	Draw	
			Rur. econ		Bk. keep		
		Phys. cult			Shop work		Phys. cult.
	Mil. tact	Mil. tact	Mil. tact		Mil. tact		Mil. tact.
II	Agric			Agric	Agric	Agric	
	Hort				Hort	Hort	
		Phys				Phys	Phys.
		Chem	Chem	Chem	Chem	Chem	Chem.
	Geol				Min		
	Bot	Bot	Biol			Bot	Bot.
	Physiol	Anat		Physiol	Physiol		
		Micros		Entom	Entom		
						Alg	
		Math		Geom	Geom	Geom	Geom.
	Trig					Trig	
	Survey		Survey	Survey		Survey	
	Fr		Ger				Fr. or Ger.
	Engl	Engl		Engl		Engl	Engl.
		Pol. econ	Hist				
	Draw			Draw			
			Mech. arts		Industrial	Mech	Phys. cult.
	Mil. tact	Mil. tact			Mil. sci	Mil. tact	Mil. tact.
III	Agric	Electives in agric., hort., vet. sci., chem., bot., geol., entom., survey, civ. eng., etc	Agric	Vet. sci		Agric	
	Hort. & fores.		Hort	Hort		Hort	
	Phys		Phys		Phys	Phys	Phys.
	Chem			Chem	Chem	Chem	Chem.
			Min	Geol			Min.
			Bot	Bot			
			Anat	Physiol	Physiol	Physiol	Physiol.
	Zoöl						Zoöl.
	Entom			Entom		Entom	Entom.
	Mech			Anal. geom	Mech. & trig	Mech	
				Mech	Survey		Survey.
							Fr. or Ger.
	Engl			Engl		Engl	Engl.
	Rhet				Rhet		
					Hist. and civ. gov.		Hist. & pol. econ.
		Draw		Draw	Industrial		
	Mil. tact			Mil. tact		Mil. tact	Mil. tact.
IV	Agric	Electives in agric., hort., vet. sci., chem., bot., geol., entom., survey, civ. eng., etc.	Agric	Agric	Agric		Agric.
			Hort. & for		Hort	Hort. & for	Hort.
	Vet. sci		Vet. sci		Vet. sci	Vet. sci	
					Phys	Phys	Astron.
	Chem			Chem			
	Geol		Geol		Geol	Geol	Geol.
				Bot	Bot	Bot	Min.
				Zoöl	Zoöl	Zoöl	
	Meteor				Meteor	Meteor	
			Entom				
				Civ. eng		Civ. eng	
	Engl			Engl	Engl	Engl	
	Pol. econ		Pol. econ	Pol. econ	Pol. econ	Pol. econ	Pol. econ.
	Const. hist		Const. law	Const. law	Const	Const	
	Psychol				Psychol	Psychol	
	Farm law		Inter. law				
		Thesis	Thesis		Industrial		
	Mil. sci	Mil. sci		Mil. sci			Mil. tact.

AGRICULTURAL EXPERIMENT STATIONS
IN THE
UNITED STATES.

REPORT OF THE CHIEF OF THE WEATHER BUREAU.

SIR: I have the honor to transmit herewith a report on the work of the Weather Bureau for the last six months of the year 1891.

Very respectfully,

MARK W. HARRINGTON,
Chief.

Hon. J. M. RUSK,
Secretary.

INTRODUCTORY.

In my special report, dated October 1, 1891, I submitted a statement of the administrative work of this Bureau since its transfer on July 1. In the present report I desire to refer more at length to the scientific and practical work of the Bureau and to enlarge upon some of the features of especial interest to the public. The evident intention of Congress, as expressed in the act creating the Bureau and in the appropriation bill, as well as your own specific instructions, have made it my duty to endeavor to extend the benefits of the meteorological service to agricultural interests. Under my eminent predecessors, Generals Myer, Hazen, and Greely, the commercial requirements have been met as fully as the art of forecasting the weather would permit. This was doubtless in part because their wants were more fully met by general forecasts, and partly because forecasts when made could be more easily distributed to them. The Chief Signal Officers apparently appreciated the needs of the farmers and some effort was made to meet them, especially by my immediate predecessor, who himself initiated some of the improvements which I have endeavored to put into operation.

I embrace the opportunity to express my high appreciation of the Bureau force, in and out of Washington. The employees in the meteorological service generally remained with it after its transfer. Their hours of labor have been generally increased, in some cases to an extent which I regret and would be glad to remedy; but they have in every case responded nobly to every demand made upon them. I have found them uniformly able, enthusiastic, and trustworthy, so that I have not hesitated to give them increased responsibility and freedom of action. This is a natural result of the transfer to a civilian department, and, so far from detecting evidences of deterioration, which the critics of the transfer claimed would ensue, and even its friends feared might be the result, I believe that the actual result has been an improvement in the public service.

The state of uncertainty in which the station employees (those employed outside of Washington) were left by the transfer was speedily ended by their prompt appointment under the newly organized Weather Bureau,

and, as employees of the Department of Agriculture, they are faithfully performing the duties assigned to them. I may state here that it will add to the satisfaction of the entire force, and satisfaction always means increased efficiency, if we can be enabled by the extension to this service of civil service rules so modified as to meet its peculiar needs, to provide a proper means of admission, and, what is still more difficult, a proper test for promotion, so that every man will be dependent for admission and advancement upon his own capacity and exertion, and will know that a system is in force which will accord to each full justice on this basis. I need hardly say that it is no easy matter to devise such a system specially adapted to a service like that of the Weather Bureau, but I hope to be able in a short time to submit therefor a plan for your consideration.

I take pleasure in warmly commending the force engaged on scientific work at Washington, in which I include the able and experienced commissioned officers detailed from the Army. The forecasters performed the same duty under my predecessor. The appointment of Mr. Frank H. Bigelow as professor of meteorology has been uniformly commended. I have intrusted to him a special line of investigation, which will be mentioned later. The other members of the scientific force have routine duties intrusted to them in every case, in addition to the special researches on which they are engaged.

An endeavor has been made to enlist in our work scientific men of established reputation and not regularly connected with the Bureau. This has been fairly successful, and I hope soon to place in your hands a series of reports on various features of the practical and theoretical aspects of our work which will prove to be a notable addition to our knowledge. In these reports especial attention will be paid to the applications of meteorology to agriculture.

THE FORECASTS.

Our first care, on the transfer, was to improve the forecasts and their distribution in every possible way. The time covered by the forecasts has been lengthened to thirty-six hours, and the forecasters have been encouraged to make their predictions still longer whenever they see a fair prospect of verification. At the same time the forecasters have been instructed to put their predictions in language which will be easily understood by everybody.

Both these improvements tend to reduce the technical percentage of verification, but as they make the prediction of greater value to the public, they have been introduced. So perfectly, however, has the work of forecasting been done that the verifications have not suffered. To show this, I compare the verifications for the months for which they have been made since the transfer with those for the same months for the previous year:

Month.	1891.	1890.
July	82.9	83.1
August	82.1	84.2
September	88.7	79.4
October	88.8	83.9
November	85.8	86.2
December	88.4	83.9
Average	86.12	83.45

The most exact verification possible can not express in percentages all the features of success and failure in the work of a forecaster. The feature of the forecasts which it has been my endeavor to strengthen, namely, the making of predictions which will be of the highest possible use to the public, can not receive adequate arithmetical treatment.

THE DISTRIBUTION OF FORECASTS AND FROST AND COLD-WAVE WARNINGS.

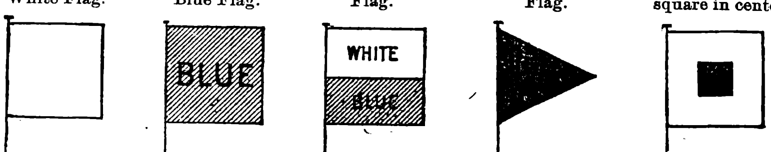
The value of the work of the Weather Bureau to the country depends largely upon its ability to distribute promptly the information collected at central points from its system of telegraph stations. The daily weather forecasts issued by the Bureau have always been recognized as of sufficient importance to be telegraphed by the Associated Press as items of news, and they are therefore distributed without expense to the service to the centers of population, and have appeared regularly in the daily journals of the country. Many efforts have been made to reach the more thinly settled portions of the country, and with the transfer of the Weather Bureau to the Agricultural Department renewed efforts are being made to extend the weather forecasts to agricultural communities. The most thorough distribution of the forecasts possible would be by telegraph daily to every telegraph office in the country, where means should be provided for the display of reports in bulletin form. Such a system can not at present be utilized owing to the small appropriations made for telegraph purposes, although it has been strongly urged by agricultural organizations throughout the country, and Congress has been petitioned repeatedly for appropriations to bear the expense attending such telegraph service. Those most interested in agriculture will not be satisfied without additional appropriations for this feature of Weather Bureau work, and it will be in the interest of the general public, including all classes, if arrangements can be made which will place the daily weather bulletin at every telegraph office in the country.

The Bureau not having the necessary funds for the extended distribution outlined above, every other available means has been utilized for placing before the public the information collected by this service, of which the following is a general outline:

The forecasts and frost and cold-wave warnings issued by this Bureau are disseminated as widely as possible, through the medium of the Associated Press, by special message (telegraph or telephone), by railroad wires, by train service, and by mail. They are received by the newspaper editor, the farmer, the merchant, the mariner, the miller, and others, and are by them disseminated by means of the flag or whistle signals adopted by the Weather Bureau, of which the following is a description:

EXPLANATION OF FLAG SIGNALS.

No. 1. White Flag.	No. 2. Blue Flag.	No. 3. White and Blue Flag.	No. 4. Black Triangular Flag.	No. 5. White Flag with black square in center.



Clear or fair weather.	Rain or snow.	Local rains or snow.	Temperature signal.	Cold wave.

No. 1, white flag, 6 feet square, indicates clear or fair weather. No. 2, blue flag, 6 feet square, indicates rain or snow. No. 3, white and blue flag (parallel bars of

white and blue), 6 feet square, indicates that local rains or showers will occur, and that the rainfall will not be general. No. 4, black triangular flag, 4 feet at the base and 6 feet in length, always refers to temperature; when placed above Nos. 1, 2, or 3 it indicates warmer weather; when placed below Nos. 1, 2, or 3 it indicates colder weather; when not displayed the indications are that the temperature will remain stationary, or that the change in temperature will not vary more than 4° from the temperature of the same hour of the preceding day from March to October, inclusive, and not more than 6° for the remaining months of the year. No. 5, white flag, 6 feet square, with black square in center, indicates the approach of a sudden and decided fall in temperature. This signal is not to be displayed unless it is expected that the temperature will fall to 42°, or lower, and is usually ordered at least twenty-four hours in advance of the cold wave. The display of the flag during the growing season indicates that injury to vegetation may be expected from frost, and at other times that the cold may prove injurious to stock and to farm products, etc., exposed in shipment. In the State of Florida, and in a strip of country 100 miles wide on the Gulf coast, and along the Pacific coast, the cold-wave flag is known as the frost-warning flag. During the late spring and early fall the cold-wave flag is also used as a frost-warning flag in other portions of the country, to indicate anticipated frosts. When No. 5 is displayed No. 4 is always omitted. When displayed on poles, the signals should be arranged to read downward; when displayed from horizontal supports a small streamer should be attached to indicate the point from which the signals are to be read.

INTERPRETATION OF DISPLAYS.

No. 1, alone, indicates fair weather, stationary temperature.
No. 2, alone, indicates rain or snow, stationary temperature.
No. 3, alone, indicates local rain or snow, stationary temperature.
No. 1, with No. 4 above it, indicates fair weather, warmer.
No. 1, with No. 4 below it, indicates fair weather, colder.
No. 2, with No. 4 above it, indicates warmer weather, rain or snow.
No. 2, with No. 4 below it, indicates colder weather, rain or snow.
No. 3, with No. 4 above it, indicates warmer weather, with local rains or snow.
No. 3, with No. 4 below it, indicates colder weather, with local rains or snow.
No. 1, with No. 5 above it, indicates fair weather, cold wave.
No. 2, with No. 5 above it, indicates wet weather, cold wave.

A system of steam-whistle signals is also in use at a number of stations, by means of which the weather conditions are communicated in places where flags can not be seen at long distances, those within range of the sound of the whistle being supplied with the code which is used at stated hours to communicate the probable weather conditions for the coming twenty-four hours. This whistle code is intended only for use at stationary engines and is not applicable to the railway.

The flag displays here outlined may be greatly extended and become a most valuable aid to farmers, shippers, and the public generally, by a little exertion and a small outlay for flags on the part of those to be benefited. The system has been adopted and is in use by some of the principal railroads throughout the country, the symbols, made of tin or sheet iron, being displayed from the baggage cars. These roads transmit over their wires each morning, to points from which trains start, the names of the symbols to be displayed on the cars. When the symbols are thus displayed they should be placed one above the other and read downward. Many large firms and corporations are displaying the flags, and at the same time advertising their business, by printing the signals and their meanings on the back of their business cards.

There being but a limited appropriation at the disposition of the Chief of the Weather Bureau for the purchase of flags, it is necessary that the utmost care be used in their distribution, in order that they may be placed in proper hands where they will be properly cared for as Government property, and used only for the purpose for which they are intended. In many instances individuals or firms procure their own signals for such displays, and upon this office being notified that

arrangements are completed for the display of signals the forecasts and warnings are telegraphed to the proper address at Government expense.

On June 30, 1891, about six hundred and thirty weather signal display stations were in operation, to which the forecasts were telegraphed or telephoned at Government expense; ninety stations receiving cold-wave warnings only, fifty-one stations being furnished with frost warnings alone, and six stations (located in California) receiving rain warnings for the benefit of the raisin-growing sections.

Since July 1, 1891, this number has been largely increased. Before the close of the year the forecasts and warnings were telegraphed or telephoned to nearly one-thousand six hundred and fifty points, at which flag signals are displayed or whistle signals sounded for the benefit of the general public.

A system of frost warnings for the benefit of cranberry and tobacco interests in operation in Wisconsin during the past season having been so thoroughly satisfactory the State service directors in the cranberry and tobacco-growing States have been instructed to perfect similar systems for the dissemination of frost warnings. A warning of a killing frost for the cranberry district of Wisconsin, on August 24, resulted in the saving of over one-third of the cranberry crop in that State, representing over $125,000. In Minnesota and the Dakotas frost warnings were issued during August of the current year to protect the grain, and little or no damage resulted where farmers used smudges to cover their fields with a dense smoke during the period of anticipated frost. In the State of Kentucky alone nearly one hundred and fifty frost-warning stations were established and are now in operation to protect the tobacco interests of that State.

The various means employed for the dissemination of forecasts and warnings have resulted in placing the information in the hands of thousands who have been heretofore unable to reap the benefits of the work of the Weather Bureau. This, as a matter of fact, has necessitated a considerable outlay, but it is believed that in every case the expense has been justified and that the service rendered has amply compensated for the cost of distribution. In the majority of cases the plan of distribution is entirely satisfactory, although rare instances of inadequate telegraph service are reported, which, as a rule, receive prompt consideration by the proper officials.

The Railway Bulletin Service has been largely utilized for the gratuitous distribution of forecasts and should be encouraged and as widely extended as possible. If the matter is properly presented to the proper officials of the railroads coöperation invariably follows in cases where companies control their own wires. At the present writing the records of this office show that over thirty railroads are coöperating in this work and posting the forecasts at nearly two thousand stations at which the information is accessible to the general public, while a number of roads distribute the reports for the benefit of their employees only, being restricted to this action by their agreement with the telegraph companies.

The telephone, for distributing forecasts, is becoming more popular with the building and extension of new lines, and it is believed in the near future will supersede the telegraph as a means to be utilized at distributing centers for reaching every point in the sections desiring to obtain the predictions of this Bureau. The more enterprising and progressive farmers, living on the routes over which the lines are strung,

avail themselves of the opportunity presented, place private telephones in their residences, and obtain the forecasts by application to their nearest exchange. Gratuitous distribution of forecasts is allowed in some instances, and a liberal policy is pursued by all telephone companies in their dealings with this Bureau and its work. It is believed that very low rate can be obtained from every line for daily messages. The only apparent objection to this manner of distribution is the fact that in damp or wet weather the lines are grounded, in a measure, and poor service necessarily follows.

Postal facilities are made use of at distributing centers as far as possible in distributing the forecasts to near outlying points, and quite a number of individuals are now receiving the reports by mail who formerly were furnished the same information by telegraph.

It has long been the desire of this Bureau to devise some method by means of which a legible and clearly printed map could be published in the daily journals, and several attempts have been made but without satisfactory results until quite recently. Through the efforts of the forecast official at Atlanta, Ga., in coöperation with the officials of the Atlanta Constitution, a satisfactory daily weather map is now regularly issued in that journal, and a number of the more prominent journals of the country, seeing the advantage that will result from this undertaking, are preparing to do the same thing. Should this feature be adopted by the daily journals of the country it would not only add greatly to the distribution of the weather forecasts, but the appearance of the chart would doubtless create an interest in the work of the Bureau, the public would become familiar with the map and its uses, and intelligently apply to their interests the information thus given.

The majority of the means now employed in the dissemination of the forecasts and warnings present more or less difficulty, which must be overcome to secure prompt and efficient service and prevent complaints on the part of the recipients, but every effort is being made at all times to perfect the work of distribution and economize in the disbursement of the appropriation allowed for this purpose, without reflecting discredit on the Bureau or subjecting it to adverse criticism.

Great as is the practical value of the system of forecasts, it may be shown that this system, without any change of methods or amounts of observations, and equally with no diminution of territory concerned, is susceptible of marked extension, which will enable its benefits to reach several times the number of persons who now find the prediction of coming weather changes a matter of economic advantage. Hitherto the course of issuing forecasts for a period narrowly restricted to one day in advance has limited their first benefits to the urban and suburban residents. To give these benefits to a much larger and equally interested portion of the community is possible by the process of simple extension, and, being possible, may well claim consideration in behalf of the foremost producers of the wealth of the state.

Inclosed within the boundaries of our country, marked by varying influences exerted from without, the field equally varies in its interior parts. It presents the strongly marked individualities of mountain and valley, coast and insular climates, with the addition of a most important region of central plain over which it is a necessary but difficult task to follow out the combined or successive application of the many external and internal factors. The field thus constituted must be ever kept in mind by the forecasting official in order that from the

particular individualities of each storm area and the more permanent modifications introduced by the geographical physics of the land, he may issue a reliable statement of impending weather changes at such a time in advance as may secure the benefits of this knowledge to the greatest number.

To issue this information, in other words to forecast the weather, is a matter which depends upon recognizing the approach of an area of disturbance at the earliest moment, and upon watching its development most closely with equal regard to the presence in other parts of the country of other climatic elements which may affect the future path of the disturbing area and its rate of speed of translation along that path. When the development has progressed to a certain extent it becomes possible to correlate this area with others similarly originated, and thus having brought it into connection with a certain type recognized by past familiarity with these meteors, it is a legitimate process of induction to assign to the individual the average characteristic of the type as known. In proportion as it is practicable to appreciate the type relations of an approaching storm area at an early period and with certainty, so is it possible to issue warnings of its approach for the benefit of those in the line of its march of progress whose industries are so likely to be affected beneficially or injuriously by the passage of the storm as to make early knowledge of its coming a positive advantage. But as climatic physics is not as yet an exact science, it must not be forgotten that the farther from the storm front the warning runs the greater is the chance that some unforeseen modification of path or rate may interfere to vitiate to a certain degree the accurate value of the warning.

The problem is not one to be lightly approached. It has initial difficulties in the attempt to pick out of the obscure and ill-defined beginnings of an atmospheric movement the generic and specific characters of the type which must precede any estimate of its growth and movement. Along its course it is also beset with difficulties in the recognition by obscure and often almost inappreciable signs of the existence of perturbing forces, which, in the interval between two successive observations, may so divert or impede the storm progress as to bring it under a type needing different treatment. Never easy, the problem becomes more difficult when it is sought to go before the storm at any but short intervals of space and time. Likewise there is a complication of the problem introduced by the change of the seasons wherein the solar influences induce rapid or lagging movements of the storm areas. The prime essential without which the forecast can not hope to rise above an unreasoning guess is, then, to look upon the storm area as a physical entity concerning which it is possible to predicate breadth, course, and speed. This entity being exposed to perturbations in its course, a new difficulty is introduced by the fact that an area of atmospheric disturbance may so distinctly change its character while in progress as to vitiate all foreannouncements, except such as are expressed in the most general terms and for times and places removed to such a limit in advance as may allow the issuance of a second forecast, revised in accordance with the altered conditions. Nor does the difficulty end with this. In a territory so wide it is possible that storm areas may die out entirely; or, on the other hand, such meteors may develop without warning from apparently neutral conditions, and these are matters which it is as impossible to predict as it is beyond the power of mind to foresee.

Having such factors to deal with, and subject to the modification of such coefficients of perturbation, successful forecasts are limited within certain lines, which differ from day to day and from season to season, in a manner as yet so imperfectly understood as to make the problem presented to the forecast official on his maps night and morning more a matter of empirical essay in a long chain of individual instances than a satisfactory induction. Yet many of his difficulties lose much of their force through the operation of nature's harmony with the needs of man, which finds in the seedtime and harvest of the husbandman the meteorologist's well-recognized seasons of sluggish development and slow progress of storms; and in winter, with its conditions of danger to the mariner, finds a period when the lakes are frozen, and on the seacoast a natural absence of freight for the smaller and less seaworthy vessels, which in consequence are removed from the possibility of disaster.

In general, it may be said that the maritime interests have been abundantly conserved in the issuance of forecasts and storm warnings. The fact that great ports and great cities are the same place, and that the port shares every last advantage of publication of information which the city affords, has served to transmit to the seaman the warning of approaching gales as rapidly as it has been found possible to reach any party in interest. Beyond this general system of information the marine interest has received particular attention in the winter season, when violent conditions are of quick development and speedy translation, and are as quickly handled by the display of warning signals that respond to the telegraph and may be appreciated by a glance of the eye.

Commerce afloat and commerce ashore have been so favorably situated as to command the advantage of learning sufficiently in advance any change which may be impending. But before this information has been brought to the farmer, to whom, as representing the productive interests with which commerce must concern itself, it is of equal if not greater applicability, much time has been lost, and that, too, in a matter where time is of the utmost consequence. The delay in transmission continues irremediable, and must ever be due to the fact that time is requisite to publish the information and to distribute it where needed under the condition that, as the population is more widely scattered, the channels of transmission operate more slowly and correspondingly with less efficiency. To meet the needs of all agricultural industry, in recognition of its right to receive from the Weather Bureau a service to the full as efficient as is afforded any element of the population, this problem has been studied in detail. The delays in publication and transmission remaining constant, as they must, the remedy must accordingly be sought in some plan of extending the time predicted for by such a period as will take note of this constant factor of delay, and give to the average agricultural community its information as to the approach of weather changes at such time in advance as will allow it to take measures accordingly to protect itself.

This demand is now met by a general statement presenting useful probabilities of coming changes of the weather. The adoption of this general synopsis has been tentative in its character, both by reason of natural hesitation at entering upon a new and untried procedure, and equally by reason of the necessity of avoiding any alteration of the more positive character of the district predictions as now authorized. The present system of forecasts has been suffered to remain unmodified, but nevertheless the Weather Bureau has recognized the paramount neces-

sity of giving to agricultural communities, more slowly reached, such early information as may be of service in their varying needs. Under this system the prominent characteristics of each day's meteorological elements are discussed in popular terms, the history of each threatening meteor is narrated, and particular attention is called to the presentation of the probable path which it will follow over the country, the rate of movement which it may be expected to attain within that path, and the whole is summed up by judicious warning to those to whom the storm path and progress may be of interest and value. Thus has grown up, in addition to the official predictions, which lie under limitations of time and degree, a system of freer secondary warnings for two and three days in advance, and frequently over half a week ahead, of which the value is becoming daily more conspicuously manifest. The initiation and development of this additional system is to be laid to the credit of one of the officers of the Army retained on temporary designation for duty under the Secretary of Agriculture. This official was willing to undertake the additional care if only the advantages of the service rendered might be extended as far as possible and the usefulness of the Bureau further broadened. Its simple beginning was the making of a statement of the general weather conditions; its extension has been to present fuller details, without the sacrifice of any of the simplicity and utility which are necessarily a prime desideratum.

The same impulse has led in the official system of predictions to the presentation of forecasts for not only the ensuing twenty-four hours, but for the succeeding day as well, in almost every instance. As illustrating this endeavor to increase the range of the authorized forecasts, it is well to draw a comparison between those of the five months from July to November, inclusive, of the current year and the corresponding five months of 1890. These are not the reasonable probabilities that form the topic of the general bulletin, but are the forecasts made at night for the second day, and included in the dispatches published in the papers and sent to correspondents of the Bureau.

Number of forty-eight-hour predictions:	
July 1, 1890, to July 1, 1891	2,189
July 1, 1890, to December 1, 1890	731
July 1, 1891, to December 1, 1891	3,523
Percentage of increase:	
Five months 1891 over five months 1890	382
Five months 1891 over twelve months 1890-'91	61

The system thus devised for the extension of the benefits of weather foreknowledge has, in Washington, been of intermittent application. Beyond the central office it has hardly gone at all, except to a few metropolitan centers; and though it has received appreciative attention in the large cities, that was by no means the end which the originator of the system set before himself, namely, the improvement of the service in its relation to the industries of those who produce wealth at a distance from the cities which consume it. An organization well adapted for extending the advantages of this subsidiary system is now available without altering existing methods.

This machinery of distribution exists in a new system of local forecast officials. To avoid loss of the skill which a few have acquired in the work of weather prediction, and at the same time to afford the highest degree of practical training to those who must ultimately succeed to their work when they lay it down, a plan has been under careful

consideration of dividing the two daily forecasts between the local forecast officials and those at the central bureau. The problem thus presented has by no means been solved, but the advisability appears in full measure of apportioning the morning report to the several local officials, each in his own district, and of reserving to the professors of the Bureau and others qualified for the work the preparation of the night bulletin, with its wide circulation and valuable information of cold waves, river stages, and wind signals.

It is to be expected that the effort to institute this additional improvement will encounter the objection that it is not fairly reducible to the present mode of verification. The answer to this objection, if raised, is that the object sought is to remove the general synopsis from the domain of that which is technically known as verification. That practice of the office is not based on a legitimate footing. Without entering upon the detail of the manner in which a practice initially designed to assist forecast officials in their professional study has elevated itself into a custom of rigorous application, it is sufficient to repeat the assertion that the statement of probabilities designed for the farmer's guidance must be free from the rigid definitions of arithmetical verification. That custom has always hampered those who have worked under the constraint which it imposes, and has entailed needless criticism upon the work.

In fine, it is to be said that here is offered a method, already tried, by which the plain probabilities of American weather may be foreannounced in plain American speech in order that the farmer may know whether or not he is to have fair weather for the care of his crops, and if storms do come, that he may have some idea of what his delay is likely to be. It has also been shown that this can be done without altering a single condition of the official predictions now authorized. It has been shown that the objection which might be raised on the score of verification will never prevail against the popular verification of an appreciative community when it receives, as has long been desired, its knowledge of to-morrow's weather in season to make it useful.

THE WEATHER MAP.

The weather map is based on observations made morning and evening at 8 o'clock, seventy-fifth meridian time, at one hundred and sixty places throughout the United States and the Dominion of Canada, and is issued twice a day. Data as to the condition of the weather are thus gathered from an extent of more than 3,500,000 square miles of the earth's surface, about one-fortieth part of the whole surface of the globe. Information is also received from the West Indies at times when severe storms prevail there, and occasionally also from Bermuda Islands.

The observations taken at a place comprise the pressure of the air; the temperature at time of observation; the highest temperature of the day and the lowest; the moisture; the wind direction; the velocity of wind for five minutes at the time of observation; the depth of rainfall for the preceding twelve hours when the observation is made in the evening, and for the preceding twenty-four hours when the observation is made in the morning; the condition of the weather at the time of observation, whether clear, raining, snowy, foggy, or hazy; the condition of the sky as to clouds and the kind of clouds; the direction of their motion and the proportion of sky covered.

These observations are telegraphed to the central office of the Weather Bureau at Washington, D. C., with the aid of a cipher code designed for the purpose of saving time and expense in the transmission of the messages. As a rule, a message consists of ten words. The cipher is so constructed that a person familiar with the key can quickly translate the message without reference to the key and without consulting an index of words. As the cipher messages are received a skilled translator reads each of them in the terms expressed by the cipher. An assistant enters the data upon a map of the country near the location of the particular place.

When all the data are entered on the map, it is generalized by lines representing graphically the various conditions of the air and the changes going on.

The lines on the specimen weather maps adjoining represent pressure and temperature distribution over the country. Shaded areas show where there has been rainfall in twelve hours preceding the time of observation. Heavy dotted lines inclose areas of great temperature fall. A line of arrows indicates the path followed by the center of low pressure. Circular symbols show the condition of the weather and the sky, and the circles with arrows the wind direction.

This map, made up from observations at 8 o'clock, is issued two hours and a half later in a number of the large cities throughout the country, and is posted in post-offices, custom-houses, boards of trade, and maritime exchanges. In the aggregate 5,000 copies of the weather map are issued daily, except Sundays, at sixty-three cities. The maps given here are on a reduced scale, the actual size being 22 by 16 inches.

On the printed weather map issued at Washington the principal data for the various stations are given in figures, in tabular form, on the side of the map.

The pressure of air varies greatly at different times. The average pressure is equal to what would be exerted by a layer of water 34 feet in depth, or a depth of about 30 inches of mercury. On the weather map pressures are always expressed in equivalent heights of a column of mercury as ascertained by the observation of a barometer. The pressure may be as low as 29.0 inches, or occasionally even less. Sometimes it is as high as 31.0, the highest ever observed in the United States being 31.12 inches.

As the height of a column of mercury varies with its temperature, independently of the air pressure, on account of expansion, all observed pressures are reduced to what they would be if the temperature of the mercury was 32°.

Great and widespread changes of air-pressure are closely related to weather changes, especially high winds.

Besides the effect due to weather, the air-pressure diminishes with height in the air or altitude above sea level. The observations made throughout the country being at places situated at various heights above the sea, from 50 feet to 1,000 feet or more, it is necessary for the purpose of comparing them that they be reduced to some common plane. The plane selected for this purpose is sea level. Before telegraphing the observation, the pressure observed at any place is first reduced to what it would be at sea level; the amount of the reduction depends on the height of the place and the temperature of the air at the time. At a height of 1,000 feet the reduction amounts to about 0.90 of an inch, to be added to an observed pressure.

The corrected and reduced air-pressures are inscribed on a map and are represented graphically by lines drawn through places where the pressures are equal. These lines (called isobars, meaning equal pressures) are drawn for pressures 0.1 of an inch apart for 30.0, 29.9, 29.8 inches, etc. The 30-inch pressure line is drawn through all the points with pressures of 30 inches. There may be only a few such actually observed pressures on the map, exactly equal to 30 inches, but many such points can be determined by interpolation from the pressures above and below 30; for instance, if the pressure at Springfield, Ill., is 29.95 and at St. Louis, Mo., 30.05, it may be inferred that the 30-inch line will pass halfway between those places, and the line is drawn accordingly.

The distribution of temperature over the country is graphically shown by lines drawn through places of equal temperature. These are called isotherms, meaning equal temperatures. On the specimen weather maps the isotherms are shown by dotted lines. They are drawn for every ten degrees—60°, 50°, 40°, etc. They are located principally by interpolation, the same as in the case of the isobars. With a temperature, for instance, of 35° at Memphis and 45° at Vicksburg, the 40° isotherm is drawn halfway between them. If the temperature was 32° at Memphis and 42° at Vicksburg, the 40° isotherm would be four-fifths of the way from Memphis to Vicksburg.

On the weather-map the direction of the wind at a place is shown by an arrow flying with the wind, . This, it is to be noted, is the very reverse of a written or spoken description of wind direction. A northwest wind always means a wind coming from the northwest; on the weather map, however, it is represented by an arrow pointing southeast.

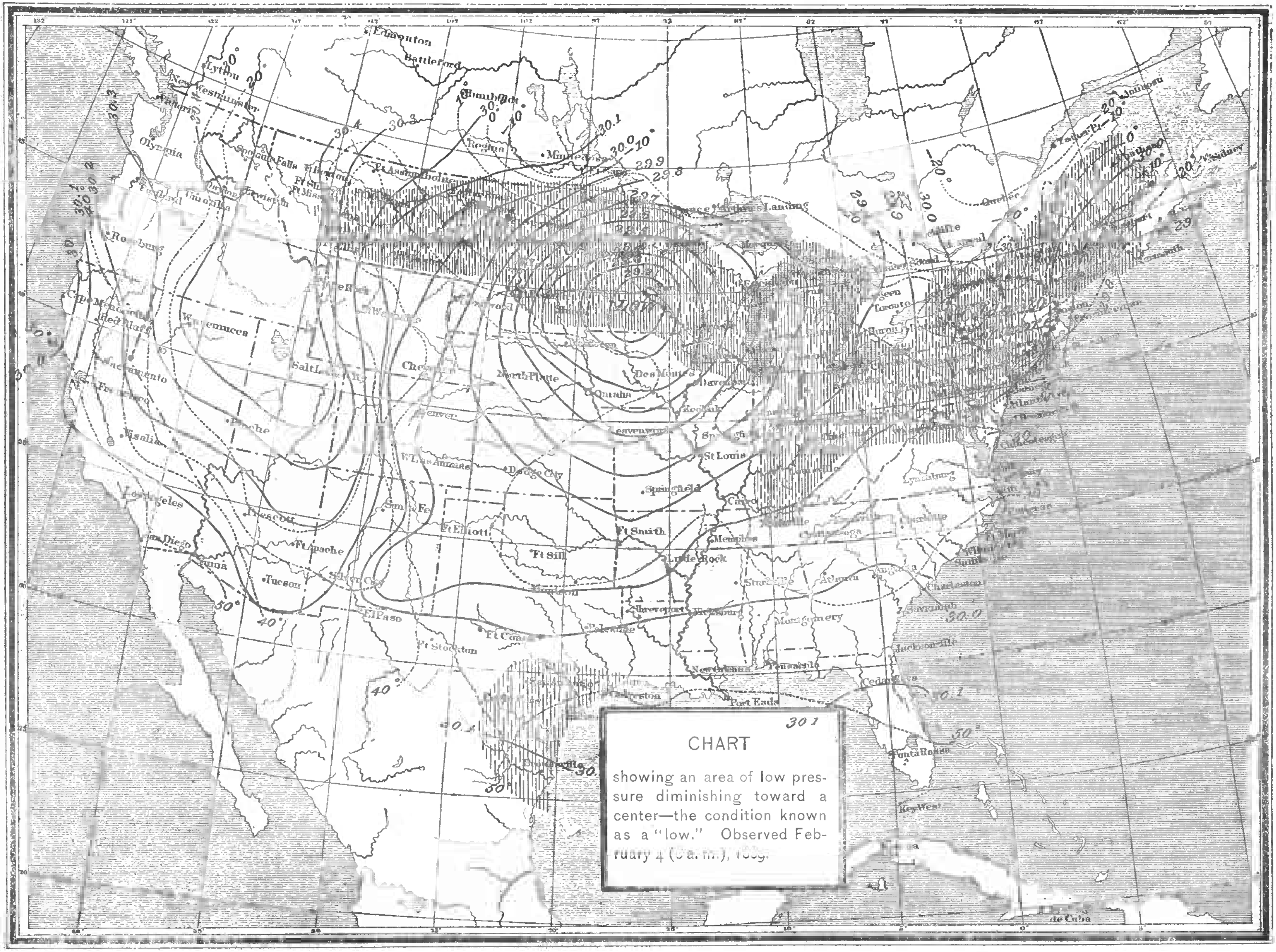
Of the symbols, a circle, ○, at a place indicates clear sky and fair weather at the time of observation; a full black dot, , indicates that it is raining; a cross-barred dot, , indicates that it is snowing; a black dot, with a white center, , indicates wholly clouded sky; a dot with black bar, , indicates a sky half-clouded.

A series of concentric isobars, showing an area of pressure diminishing toward a center, is called a "low." Such a map is that of February 4, 1889 (Plate I), where the pressure is as low as 29.2 inches in Minnesota. This type of pressure distribution is commonly associated with the occurrence of rain or snow and high winds over a wide area of country, especially in winter. Rain is likely to occur for a distance of 500 to 700 miles to the east of a decided low center.

These areas of low pressure traverse the country from west to east and from southwest to northeast. Sometimes they move in from the northwest and, turning in the region of the lower Missouri River, move to the northeast over the Great Lakes to the Gulf of St. Lawrence; at other times they pursue a southeast course as far as the Gulf of Mexico and then turn northeast; this latter, however, is only apt to occur in winter.

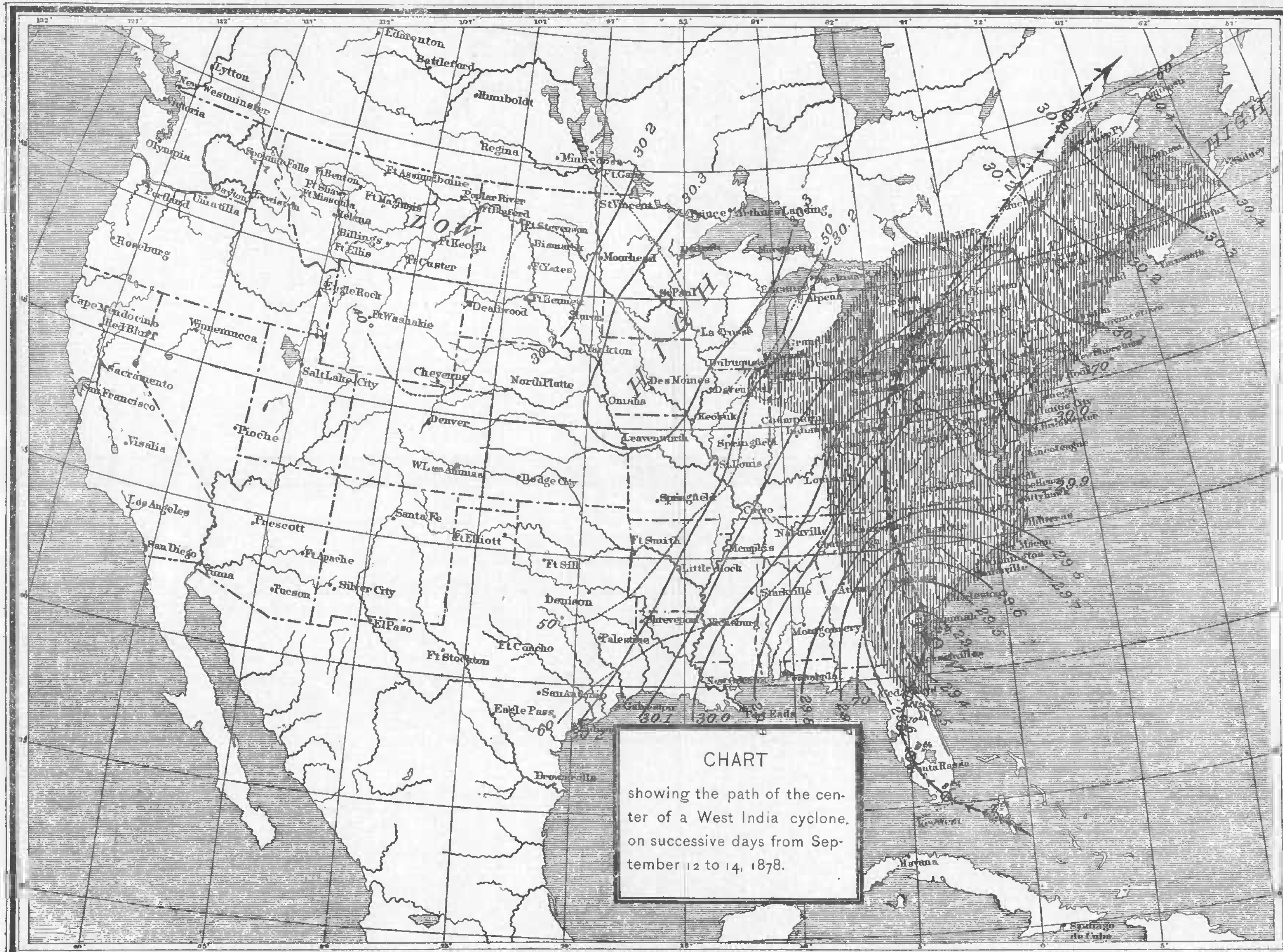
The average velocity of low centers is about 32 miles an hour. The motion is more decided and definite in winter than in summer.

There is a type of low pressure which originates in the West Indies, and, moving northwest, turns to the northeast on the south Atlantic coast or in the Gulf of Mexico. These "lows," commonly called



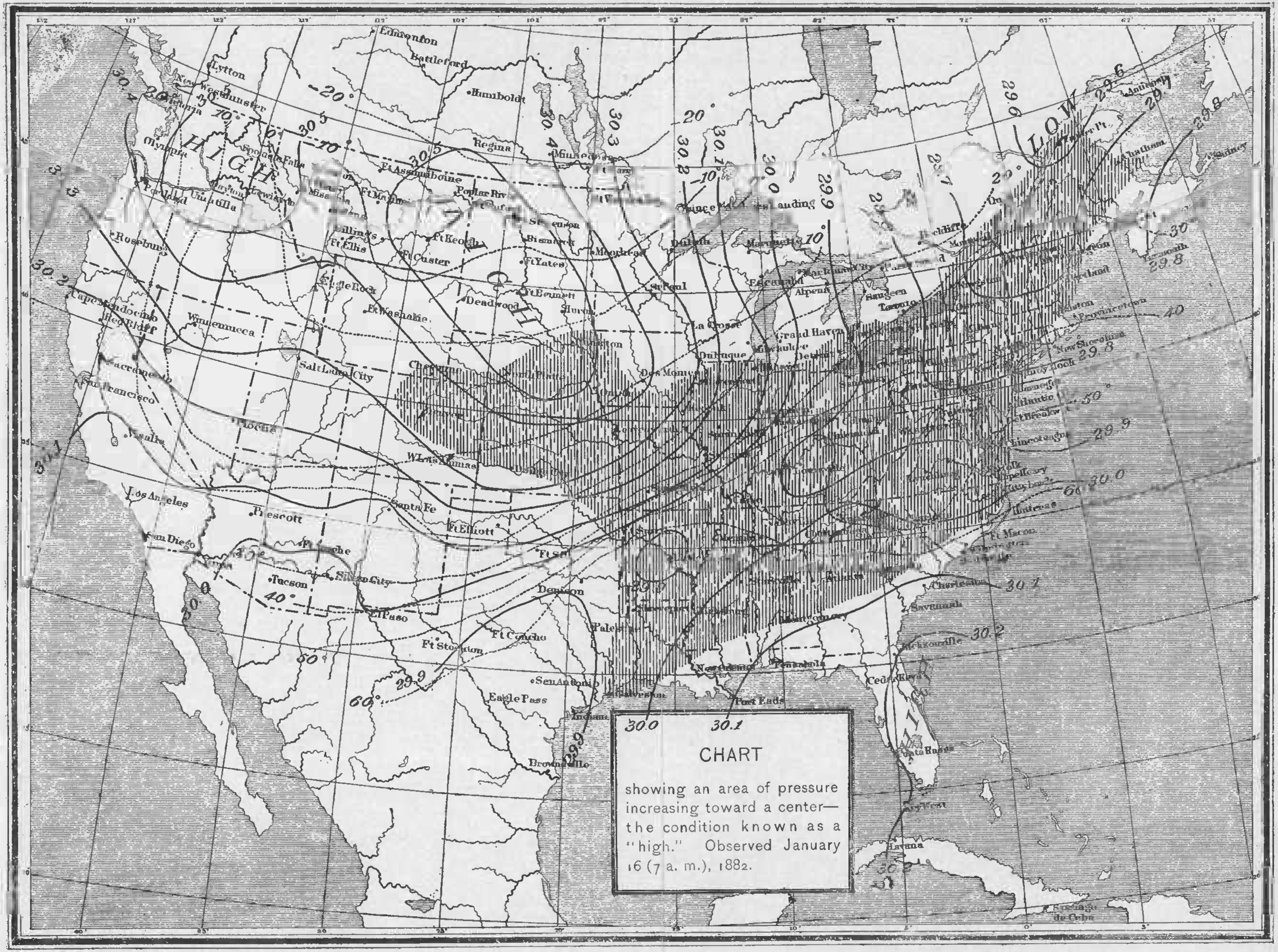
CHART

showing an area of low pressure diminishing toward a center—the condition known as a "low." Observed February 4 (8 a. m.), 1889.



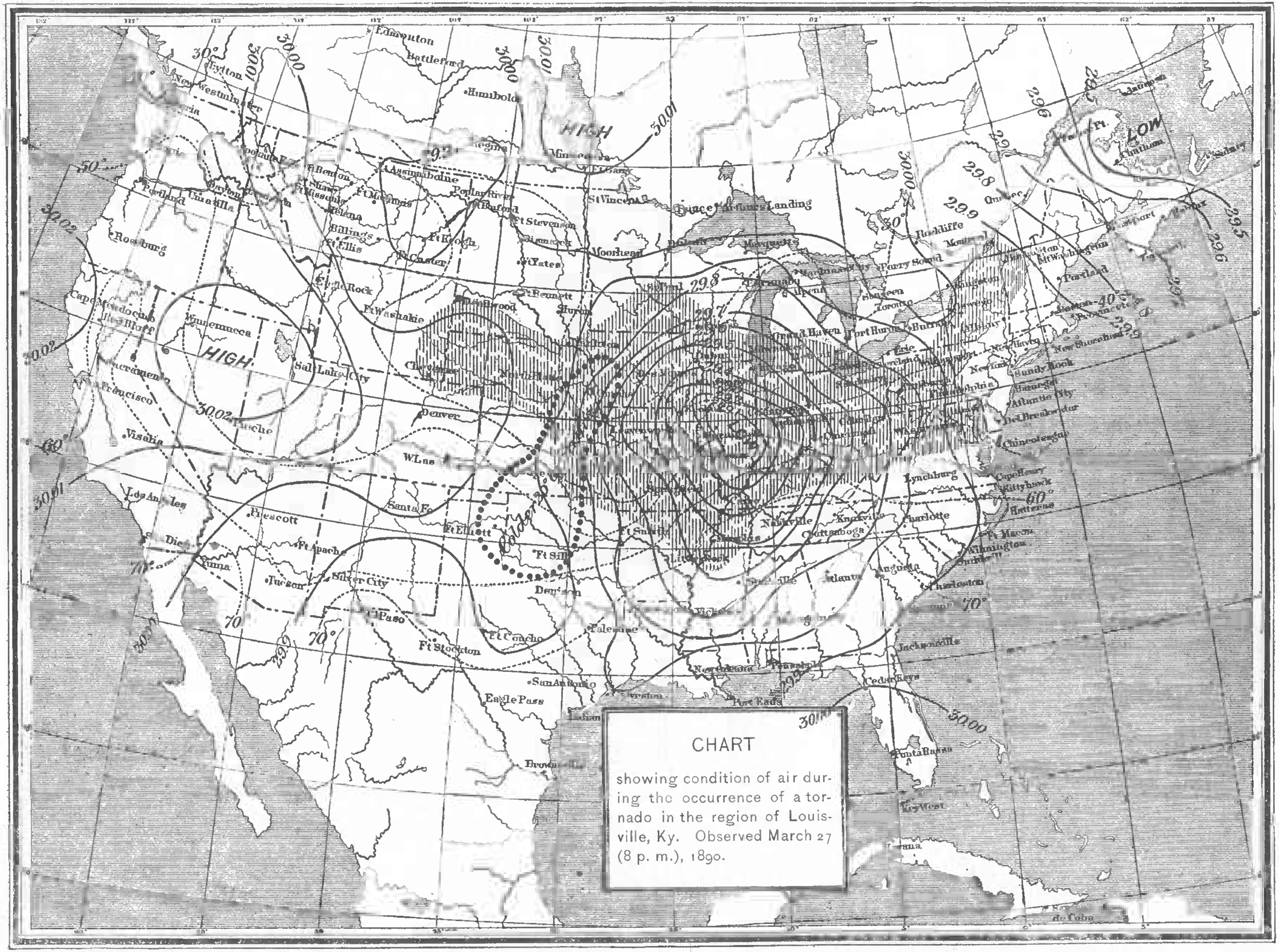
CHART

showing the path of the center of a West India cyclone, on successive days from September 12 to 14, 1878.



CHART

showing an area of pressure increasing toward a center—the condition known as a "high." Observed January 16 (7 a. m.), 1882.



CHART

showing condition of air during the occurrence of a tornado in the region of Louisville, Ky. Observed March 27 (8 p. m.), 1890.

cyclones, occur chiefly in August and September, and are accompanied by great downpours of rain and devastating hurricane winds.

On the weather map of September 12, 1878 (Plate II), is shown the path of the center of a West India cyclone marked by a series of arrows, and its position at 7:35 a. m. on successive days from September 12 to 14.

Sometimes the isobars over the country indicate an increase of pressure over a wide irregular area toward a center. Such a case is that on the map of January 16, 1882 (Plate III), where the pressure over Nebraska, North and South Dakota, Montana, and Wyoming is 30.5 inches. These areas of pressure are called "highs." The isobars in a "high" are not as regular as in the case of a "low." The "high" ordinarily covers a far greater area than a "low." In cases of great development it has a tendency to a triangular rather than a circular form.

The "highs" always originate in the west or northwest and generally move in a southeasterly direction, but very vaguely and indefinitely.

A "high" almost invariably marks a region of low temperature. Light snows, usually not more than the equivalent of 0.1 of an inch of water in depth, ordinarily occur to the southeast of a "high."

The whole matter of weather prediction is based on observations made at the same instant of time over a wide extent of country and on the known general progression of weather changes that have been by this means observed to take place in many cases in the past. There is a general tendency for the weather changes to advance from the west toward the east in the United States. Skill in predicting weather is gained by long familiarity with the weather maps and a close attention to the precedent conditions of pressure and temperature distribution that are observed to occur before very considerable weather changes. By long study of the weather maps there is finally gained, as it were, an intuitive perception of coming great changes.

The very great changes can be foreseen almost to a certainty in most cases by a skilled forecaster. The ordinary and slight changes, that for the most part are the ones usually occurring, it is not possible in most cases to correctly predict.

As "lows" move over the country the temperature rises to the east of the centers. There is a marked tendency for "lows" to move toward the region having the greatest rainfall in twelve hours preceding. As a "high" moves down from the northwest the temperature falls in front of it. With an opportune succession of a "low" and a "high" the temperature may fall as much as 60° in twenty-four hours, and the area covered by a fall of 20° and more in such cases may be a million square miles or more.

A great fall of temperature over an extensive area of country is called a "cold wave." Following the "low" of February 4, 1889 (Plate I), there was a fall of temperature of 54° in Minnesota, and the area over which a fall of 20° or more occurred was 658,000 square miles. Succeeding the map of January 16, 1882 (Plate III), the area of temperature fall greater than 20° was more than a million square miles.

The extent and depth of a "cold wave" depend in a measure on the extent of the "low" and "high" preceding it, and on the contrast of temperature over the region between the centers of the "low" and the "high." The temperature from the center of a "low" into a "high" may diminish from 60° to 0°, or even as low as −40°, in a distance varying, in different cases, from 400 to 1,400 miles.

The occurrence of tornadoes in many cases is associated with the presence of a low-pressure area over the country. The tornado is apt to occur about 300 miles to the southeast of the center of a "low" in which the pressure at center is lower than 29.4 inches and the isobars are very symmetrical or nearly circular.

The condition of air shown on weather map of March 27, 1890, 8 p. m. (Plate IV), was about simultaneous with the great tornado at Louisville, Ky., that occurred that day.

High winds, dangerous to shipping, are associated with the passage of "lows" and "highs" across the country. The strength of the wind over a region depends greatly on the contrast of pressure over it; the greater the difference of pressure in a given distance the stronger the wind is likely to be.

The change in pressure over a region is called the gradient. The closer the isobars are together the greater the gradient. As a general thing, winds of storm force, at least 40 miles an hour, lasting for a considerable time, do not occur with pressure gradients less than 0.4 of an inch in 500 miles.

Storm winds are preceded by a sudden fall in the air pressure. A fall of three-tenths of an inch in twelve hours over an area of at least 100,000 square miles is a common indication of a coming heavy blow.

The direction of wind around a low-pressure area is spirally inward, contrary to the direction of motion of the hands of a watch held with the face uppermost. In an area of high pressure the winds are out from the center and of slight force, except where a "high" is close to a "low" which is to the east or southeast of the "high." In this case the winds blowing out of the "high" into the "low" may be of very great intensity.

Particular attention has been given to the improvement of the maps, and the stations issuing them were informed that nothing but the most satisfactory results in this respect would be accepted. In place of the custom before existing, of only sending a copy of the map issued on Saturday, they were required to send to this office the poorest copy of every issue of the maps. By this course this office had the means of at once knowing when a poor map issue was made, so that action to correct it might be taken. At many stations complaint was made that on account of the poor quality of stencil paper furnished them the observers were unable to do better work. For this reason a better quality of stencil paper was immediately secured, at some additional expense. At the same time the observers were required to give that close personal attention to the matter without which good work can not be done with the best material. The result has been that the appearance, legibility, etc., of the maps have been greatly improved, and there is now rarely any complaint on that account. The issue of maps has also been authorized at Albany, N. Y.; Charlotte, N. C.; Charleston, S. C.; Marquette, Mich.; Green Bay, Wis.; Parkersburg, W. Va.; Eastport, Me., and Omaha, Nebr., stations not heretofore issuing them. The edition of the maps at all stations has been very largely increased, and they are distributed, without charge, to persons who will display them for the information of the public. The maps are prepared at the stations with the greatest possible speed, upon the receipt of the telegraphic reports, so as to catch all the mail trains, upon which they are dispatched to postmasters and others for display in cities and towns that can be reached in time for the information to be of benefit.

The weather maps are now issued at over sixty of the more important

stations, and are considered a most important feature of the service, as their usefulness is being appreciated by an ever-widening circle. They not only contain, as a rule, the forecasts prepared in Washington and the local forecasts, but also the data on which the forecasts are based, with a synopsis of the general meteorological conditions and probable direction of movement of storm centers, etc., so that they may be studied and personal conclusions be drawn by those engaged in any profession or calling affected by the weather, and this includes nearly all classes of business. In several of the large cities school superintendents and teachers have become much interested in these maps, hundreds of which are now furnished daily for study by the pupils. Information by lectures, etc., was given by the observers to the teachers as to data, practical deductions therefrom, etc. Several hundred agricultural newspapers and periodicals were recently put on the list and now receive the map daily. A very large edition of "Explanation of the Weather Chart" is about to be published for the information of those interested, and especially for those engaged in agricultural pursuits, to reach whom with these maps every effort is being made.

It is only when some change is made in the weather maps that it is learned how many and various are the classes of people who find it profitable to make a study of them. There is no doubt that the increasing issue of these maps is educating a constantly increasing number of persons as to their proper use. It is beginning to be realized that by study of the information contained on the maps, in connection with local weather signs, practical deductions as to coming weather changes may be made with profit by all who give the slight attention necessary to an intelligent understanding of the general principles outlined above governing the movement of storms over the United States.

Such is the growing appreciation of the maps that the total edition at all stations, which, on June 30, 1891, was 3,100, has had to be steadily increased, until at present (December), over 5,000 copies are issued daily; a total of over 1,500,000 a year, which will doubtless have to be still further increased. To meet the expense of this very large addition, saving was effected in other directions; for instance, by reducing the number of reports telegraphed to stations, without, however, materially curtailing in that direction.

FLOOD PREDICTIONS.

The stages of water at a number of important places on rivers are telegraphed with the weather report. These stages are printed on the weather map issued from Washington, D. C. A coming great rise of water is predicted for points along the lower course of a river when there occurs a rise along the upper course. The judgment of predicting officials is based on what has occurred in previous cases of high water for which there are records of the water stages. Records of daily stages of water have been kept at some places for more than thirty years.

To assist in predicting the stages of water, tables showing corresponding crests of high water at various points along the rivers have been prepared. Where the rise at a point in a main stream is the result of rises in a number of tributary rivers—as, for instance, at Cairo, Ill., where a rise is the result of rises in the Upper Ohio, the Upper Mississippi, the Tennessee, the Cumberland, and the Wabash—a special rule has to be devised for predicting the stages.

Important rises in the river are predicted three days ahead for Cincinnati, being based on the stages observed at Parkersburg, W. Va., Charleston, W. Va., and Louisa, Ky. For Cairo, Ill., predictions of river stages are made six days in advance of their occurrence, and for Vicksburg, Miss., seven days in advance.

STATE WEATHER SERVICE DIVISION.

At this time there are forty-one weather services, either in operation or in process of organization, representing every State and Territory in the United States with the exception of Idaho and the Indian Territory. The territory covered by the New England Meteorological Society embraces the six New England States, and the Maryland weather service includes Delaware. Elsewhere each State or Territory has its independent service.

In New York, Pennsylvania, New Jersey, Ohio, Michigan, Colorado, Iowa, South Dakota, local weather services have been organized, and supported by State laws; and in California and Nevada they have been supported through coöperation of State boards of agriculture. In New England the service is conducted under the auspices of the New England Meteorological Society, and has received no aid from the States forming its territory. The Maryland service, including Delaware, is in coöperation with the Johns Hopkins University; the North Carolina service is aided by coöperation of the experimental stations; the South Carolina service was supported by the State board of agriculture, but this support has been withdrawn and it is now aided only by the national service. In Georgia the service is in coöperation with the Atlanta "Constitution." In Alabama some assistance has been received from the experiment station, but the service relies largely upon such support as can be extended by the National Bureau. In Louisiana and Texas the commercial exchanges coöperate. The Arkansas weather service is in coöperation with the "Arkansas bureau of mines, manufactures, and agriculture." The Tennessee service formerly coöperated with the State board of health, but recently the local forecast official of the Weather Bureau at Nashville was made its director, and the service now coöperates with the State officials representing agricultural interests. In Nebraska the service has received much assistance through Prof. G. D. Swezey, of Doane College, Crete. The Kansas service coöperates with the State board of agriculture. In Florida a service is in process of organization, with the Weather Bureau observer at Jacksonville in charge. The Territorial service of Arizona is assisted by the experiment station. Local services in the following-named States and Territories receive no assistance other than that extended by the National Weather Bureau, viz: Colorado, Illinois, Indiana, Kentucky, Minnesota, Mississippi, Montana, New Mexico, North Dakota, Oklahoma, Utah, Washington, West Virginia, Wisconsin, and Wyoming.

The National Bureau has extended substantial aid to all the services, furnishing supplies for the crop bulletins, blank forms for meteorological records, and issuing meteorological instruments where needed, as far as possible.

The Weather Crop Bulletin, issued by this Bureau weekly, has been greatly appreciated during the current season by those interested in agriculture, as it presents truthful statements of the condition of the

staple crops at short intervals, and these statements, having been distributed throughout the country, have enabled the producer to become familiar with the exact crop prospects and, therefore, to form a correct estimate of the probable value of the product in which he is interested. The last bulletin for the season of 1891 was that for the week ended October 2. The work pertaining to this branch of the service is performed in a division known as the State Weather Service Division, which has charge of the preparation of the weekly and monthly crop bulletins and a supervision of the work of coöperating State services, reports from which form the basis of the crop bulletins.

This division also has charge of the establishment of stations for the display of weather signals and the distribution of frost warnings. Immediately upon the organization of this division correspondence was entered into with the weather observers in several States where State weather services were not organized, and this correspondence has resulted in the establishment of new State and Territorial services, so that at present almost every State and Territory in the Union is provided with a locol coöperative weather service, which forms a channel through which the benefits of the work of the National Service may be conveyed more extensively and more promptly to the people.

Since the 1st of July new weather services have been organized in Arizona, California, Florida, Georgia, Maryland and Delaware, Montana, New Mexico, North Dakota, Oklahoma, Utah, Virginia, Washington, West Virginia, and Wyoming, making the number of State services in operation on December 1, 1891, forty-one.

While the organization of new State services has been in progress much attention has been devoted to a general supervision of the work of those coöperating services previously established, the desire being to greatly increase the number of voluntary meteorological observers and crop correspondents and to effect a more thorough dissemination of current weather crop information among those classes of people most likely to be benefited thereby. More than one hundred and seventy-five voluntary meterological stations have been established and equipped with instruments at the expense of this Bureau since July 1, and nearly one hundred have been established by this Bureau but were furnished with instruments at private expense.

The reports from voluntary observers serve a twofold purpose for agricultural societies and experiment stations, giving them accurate meteorological data on which to rely in dealing with experiments on vegetation, etc., and the reports of rainfall, temperature, sunshine, etc., are utilized weekly in the weather crop bulletins as standard meteorological features for the State or Territory, while the compiled monthly conditions are utilized in various ways in establishing the climatology of the State and as a record for physicians in the study of the relations between climate and disease.

The most practical and most highly complimented portion of the exclusive work of the State services is the issue of the weekly weather crop bulletins. These are sources of reliable information for all interested in agriculture, following up the season from week to week, so that an excellent estimate can be made at any time relative to the crops of any county, State, or the country at large. These bulletins have a thorough dissemination in all the States and Territories in which State services are in operation, and are highly spoken of by the press and public. The national bulletin, published weekly by this office during the growing-season, deals with the weather of the week throughout the country,

consisting of charts showing the departures of temperature and rainfall, the table of seasonal and weekly departures of like data, besides giving a discussion of such charts and tables, with edited telegrams received from the several State services showing the actual condition of crops and the effect of the week's weather thereon.

As a practical illustration of the utility of these bulletins may be given a statement from a correspondent, Mr. F. L. Dunbar, of the New Jersey service at Union, which is as follows:

My brother farmers come to this station within an hour after the reception of the weekly crop bulletin, to hear it read. This prompt intelligence can be obtained in no other way. The condition of the crops of the whole State is known within a circle of a mile of this station in a few minutes after the bulletin arrives, and before the close of the day in a large part of our township. To obtain just this kind of information far in advance of the farmer the sharp speculator pays a high price, and too often heretofore the farmer has accepted a price for certain products far below their actual value. It is well known that the farmer gets little enough for his produce, while the consumer is made to pay a high price. I might enlarge on the usefulness of this bulletin. The point in the following "parable" is apparent to you. We do not raise grapes here extensively. One of my neighbors has an acre promising well. A dealer saw the advantage of securing this crop rather than depend on shipments from elsewhere. Yesterday he offered the farmer what might usually seem a fair price. The farmer brought him to this station and I read to him the report from south Jersey: "Concords, seven-eighths gone; Clintons, half." The result was the speculator advanced his offer $30, and the bargain closed. The farmer told me afterward that he considered the bulletin worth just $30 to him in this instance alone. Comment: the dealer was posted; so was the farmer.

To the immigration boards and societies in the various States these services will continue to be of great importance, and will contribute much toward the development of the Western portions of the country, and could be utilized in the Southern States in showing the true conditions of climate, and thus invite immigration.

The information supplied by these services is not only of interest to emigrants studying the adaptability of the various portions of the country to certain crops, but is equally important to the medical profession and to invalids in search of reliable and unbiased information as to the climate, etc. To the State health departments of Michigan, Pennsylvania, and Tennessee these services have afforded excellent facilities for the study of climate in connection with health, etc.

The benefits resulting from State weather services have been summarized, as follows, by the late Prof. George H. Cook, PH. D., LL. D., formerly director of the New Jersey service.

They will be the means of securing better predictions of weather changes and storms; they will bring the benefits of the national service into every county participating in the local organization; they will prepare for a system of storm signals that will be widely beneficial to agricultural interests; they will give to every county the Government standards for temperature and rainfall, wind velocity, humidity, etc., which are sources of useful public information; they will put within reach of local agricultural societies means of accurate observations which, in the course of years, must be valuable to any locality in the study and adaptation of cereals; they will bring the science and methods of the National Weather Bureau within reach of the high schools of the States, offering teachers and pupils alike excellent opportunity to study a wide range of the application of science to foster and protect agricultural industry; they will lead to the collection of rainfall statistics to enable engineers to better estimate the supply of canals, also the sudden downpours to guard against in the laying out of sewers in cities; they will lead to a correct knowledge of rainfall over the various watersheds, for the purpose of giving data for supplying the waterworks of towns and villages; they will lead to the forming of reliable meteorological records for use in legal cases; they will lead to a better practice of medicine when the physicians throughout the State can study diseases with reliable and accurate meteorological facts by their side—and for sanitary purposes correct meteorological statistics are invaluable to the practitioner in applying preventive remedies.

Names of States, central stations, directors, and assistant directors under charge of the State Weather Service division of the Weather Bureau.

[Persons marked thus * are employés of the Weather Bureau.]

State and central station.	Director.	Assistant director.
Alabama, Auburn	Prof. P. H. Mell*	
Arizona, Tucson	J. C. Hayden*	
Arkansas, Little Rock	M. F. Locke	F. H. Clarke.*
California, Sacramento	James A. Barwick*	
Colorado, Denver	W. S. Miller*	
Florida, Jacksonville	E. R. Demain*	
Georgia, Atlanta	Park Morrill*	
Illinois, Springfield	John Craig*	
Indiana, Indianapolis	Prof. H. A. Huston *a*	C. F. R. Wappenhans.*
Iowa, Des Moines	J. R. Sage	George M. Chappel, M.D.*
Kansas, Topeka	Prof. J. T. Lovewell	T. B. Jennings.*
Kentucky, Louisville	Frank Burke*	
Louisiana, New Orleans	Geo. E. Hunt*	
Maryland, Baltimore	Dr. Wm. B. Clark	C. P. Cronk, M. D.*
New England Meteorological Society, Cambridge, Mass.	Prof. W. M. Davis	J. Warren Smith.*
Michigan, Detroit	N. B. Conger*	
Minnesota, Minneapolis	J. H. Harmon*	
Mississippi, University	Prof. R. B. Fulton*	
Missouri, Columbia	Mr. Levi Chubbuck	J. H. Smith.*
Montana, Helena	E. J. Glass*	
Nebraska, Crete	Prof. G. D. Swezey	G. A. Loveland.*
Nevada, Carson City	C. W. Friend	Ford A. Carpenter.*
New Jersey, New Brunswick	E. W. McGann*	
New Mexico, Santa Fé	H. B. Hersey*	
New York, Ithaca	Prof. E. A. Fuertes	R. M. Hardings.*
North Carolina, Raleigh	Dr. H. B. Battle	C. F. von Herrmann.*
Ohio, Columbus	Prof. B. F. Thomas	C. M. Strong.*
North Dakota, Bismarck	W. H. Fallon*	
Oklahoma Territory, Oklahoma City	Louis Dorman*	
Oregon, Portland	H. E. Hayes *b*	B. S. Pague.*
Pennsylvania, Philadelphia	W. P. Tatham	L. M. Dey.*
South Carolina, Columbia	A. P. Butler*	
South Dakota, Huron	S. W. Glenn*	
Tennessee, Nashville	J. B. Marbury*	
Texas, Galveston	D. D. Bryan	I. M. Cline, M. D.*
Utah, Salt Lake City	G. N. Salisbury*	
Virginia, Lynchburg	Dr. E. A. Craighill	J. N. Ryker.*
Wisconsin, Milwaukee	Willis L. Moore*	
Washington, Olympia	E. B. Olney*	
West Virginia, Parkersburg	W. W. Dent*	
Wyoming, Cheyenne	E. M. Ravencraft	

a Address, La Fayette, Ind. *b* Address, Oswego, Oregon.

PACIFIC COAST DIVISION.

Work of this division of the national service is constantly growing in importance, with increasing efficiency. By reason of the great distance from the central office at Washington, the Pacific coast has required the formation of a semi-independent service in the collection and distribution of telegraphic weather reports for the benefit of commerce and agriculture.

The area embraced by this division includes the Pacific coast States, California, Oregon, and Washington, and the western portion of the plateau regions, Arizona, Nevada, Utah, Idaho, and western Montana. This great region is brought under the influence of weather changes moving eastward from the Pacific and southward from British Columbia in such a manner that the collection of adequate telegraphic information at San Francisco has enabled the forecast official in charge there to study reports and disseminate timely warnings of atmospheric occurrences which have been received at telegraphic centers in California, Arizona, Nevada, Utah, Idaho, Oregon, and Washington under circumstances that gave results of practical value to the people.

This work, although well organized, is yet in its infancy and can be greatly enlarged with better telegraphic facilities. The extension of commercial lines of communication is progressing rapidly under the competition of rival companies. The effect of this competition has already been of service and will continue to be beneficial to the development of the work of the Weather Bureau.

The regular 8 a. m. and 8 p. m. (seventy-fifth meridian time) telegraphic reports are received at San Francisco from two Weather Bureau stations in Arizona, eight in California, two in Nevada, one in Utah, four in Oregon, six in Washington, and one in Montana. The Weather Bureau also pays for one report daily (7 a. m., Pacific time) from three railroad stations in southeastern Nevada, three in southeastern California, and four in northern Arizona. These stations cover fairly well a peculiar region of country, of little or no agricultural value at present, but from which reports are necessary in order to furnish satisfactory rain warnings to the great fruit regions of southwestern California. The establishment of these stations has already shown the value of such reports in forecasting the early rains of autumn and the occasionally heavy showers of July and August, in the mountain regions of southeastern California, southern Nevada, and northwestern Arizona.

The information from regular stations is supplemented by additional telegraphic reports, once daily (7 a. m., Pacific time), furnishing rainfall, temperature, state of weather, and direction of the wind from certain stations of the Southern Pacific Railway system, the Pacific Postal Telegraph and Cable Company, and the Western Union Telegraph Company, distributed about as follows:

The Southern Pacific Company, 90 stations in California, 23 stations in Nevada, 7 stations in Utah, 11 stations in Arizona, and 3 stations in New Mexico; the Pacific Postal, 5 stations in Oregon, 26 stations in California; the Western Union, 24 stations in California.

The voluntary railroad and telegraphic stations can not be depended upon for the same accuracy and regularity required from Government observers, yet because of the large list of active stations from these two sources information of indispensable value is always secured for daily use in connection with the more complete reports from the Weather Bureau stations. The most important data from the voluntary stations are the records of precipitation, which are in form for immediate use to serve commercial and agricultural interests in and about the large cities of California.

Oregon and Washington remain to be developed in this line of work. There are a number of railroad and telegraph stations favorably located, and the companies controlling them will doubtless coöperate with the National Weather Service, in the collection of reports which can be bulletined to advantage in the principal cities of these two great and thriving States. In this connection it is important to note that the value of precipitation data is greatly enhanced where it can be made available for daily use through the aid of the telegraph.

The natural division of the year into two seasons, the "wet" and the "dry," and their effect upon the commercial and agricultural interests of the Pacific coast, requires careful consideration by the forecast official. The "wet season" embraces the months of October to April, inclusive, and the "dry season" the remainder of the year. The seasonal year begins with July, and all averages and comparisons are made accordingly. Special attention has been given to this subject by preparing and distributing such information concerning the characteristics of each season as would prove of the greatest value to the peo-

ple. In the "dry season" the elements of temperature, wind direction, and humidity demand almost undivided attention. It is during this season that "hot northers" and "cold westers" occasionally occur in California, Nevada, and Arizona, and warm waves in Oregon and Washington.

Commercial interests in the large cities of the coast have taken advantage of timely warnings of the approach of these atmospheric changes in the purchase and sale of large quantities of produce, especially perishable fruits. During the prevalence of a "hot norther" the consumption of certain kinds of fruit is more than quadrupled in the cities of California, and the effect in the country is to greatly hasten the ripening of some fruits and retard the development of others. Knowledge of the approach and probable time of continuance of these hot winds is, therefore, of great value to horticultural interests.

The producers, commission merchants, and canning establishments of California are all deeply interested in the atmospheric changes of the "dry season," and appreciate the valuable assistance that has and can be rendered by the detailed reports and forecasts of the Weather Bureau. During the prevalence of "hot northers" many people from the interior towns of California seek the coast cities for comfort and recreation, their movements being guided more or less by the forecasts of the Weather Service. Under similar conditions people from the coast visit the interior valleys during the occurrence of warm periods, because of the advantages of a drier atmosphere and clearer sky. These facts forcibly illustrate the practical importance of weather science and the many-sided advantages of California climate.

In Arizona and Nevada weather forecasts during the dry season are not considered necessary in the present stage of agriculture and horticulture, although they will be required in the western portion of both States in the near future. In Oregon and Washington the forecasts are valued throughout the year, but especially so during the winter season. In the summer the benefits are mostly confined to commercial interests as yet, but with a greater development of the Service agricultural interests can be reached.

The character of the "wet season" measures very largely the prosperity of the entire Pacific coast and of the western portion of the Plateau regions. Normal precipitation with a uniform distribution throughout the season invigorates all classes of business and promises bountiful crops for the "dry season." During the "wet season" the attention of the forecast official has been directed almost exclusively to the study, collection, and distribution of rainfall data for the benefit of the public. The interest is such as to demand the most complete record and careful comparison of daily, monthly, and seasonal values from numerous well-selected points throughout the Pacific region. Telegraph reports obtained from all available sources have been used for the daily forecasts and otherwise placed before the people through the medium of the daily weather map and special bulletins to the press. The forecasts furnished the two press agencies in San Francisco have been telegraphed by them to over seventy daily papers published in Arizona, California, Nevada, Utah, Oregon, and Washington, thus reaching thousands of readers with practically no expense to the Government for distribution. Stronger evidence is not needed of the value of this information for the daily needs of the people.

In addition to this extensive circulation of daily forecasts at private expense, the Weather Bureau furnishes special telegrams to over one hundred well-selected points in California, Nevada, Utah, Oregon, and

Washington, where weather and temperature signals are displayed, and in some instances steam-whistles sounded to announce the probable atmospheric changes. It can readily be seen that these means of communication bring the daily work of the Weather Bureau before thousands of people, who use the information for business, pleasure, and study.

The daily weather map published at San Francisco has reached a circulation of over two hundred copies and is constantly increasing. The great interest in this publication is shown by the fact that it is distributed in Arizona, California, Nevada, Oregon, and Washington, where in many cases it arrives too late for the immediate use of forecasts, and therefore must be employed for study only. Its use is indispensable for the purpose of educating the masses of the people in a knowledge of popular meteorology and daily weather changes. Its influence has been widespread and beneficial on the Pacific coast, and it will continue to be a permanent source of the most useful information to agricultural and commercial interests.

The issue of the daily map is now confined to the morning reports, but arrangements are in course of preparation for the publication of an evening edition, which will permit of a wider and more satisfactory distribution of this valuable information.

During the "wet season," especially at its opening and near its close, forecasts of weather are of extreme value to agricultural and horticultural interests in California, Arizona, Nevada, Utah, Oregon, and Washington. Rain warnings in California for the raisin-making districts have been estimated at the value of nearly one million of dollars in a single season in the saving of crops. The effect of a heavy shower on a crop of drying raisins diminishes their value one-third by destroying the "bloom" or by making the fruit "gritty." A successful rain warning permits the trays of drying grapes to be covered with canvas, thus protecting the fruit from damage. Immediately after the rain the canvas covers are removed and the natural sun-drying proceeds. Sun-drying is decidedly preferable to drying by artificial heat, the former process securing a higher grade of fruit, while being a much less expensive system of curing, notwithstanding the expense of covering in the case of rain, which in a single instance has amounted to several hundred dollars to the largest raisin grower.

The maintenance of the Pacific coast weather service as now organized is more than justified if for no other reason than that of affording protection to the raisin-growing interests of California. In view of the superiority of the sun-drying process, the necessity and great value of daily weather forecasts to the raisin industry of California becomes at once apparent. The raisin industry embraces portions of fourteen of the largest counties in the State, and grapes are extensively cultivated in fifty-three counties. The capital invested in the vineyards of the State, according to the last census, is about ninety millions of dollars, and employment is given to over one hundred thousand people.

Forecasts of "fair but cloudy or foggy weather" have proved of practical value to the raisin districts by preventing unnecessary expense in covering the drying grapes, which, as has been shown, is a large item in the preparation of the crop for market.

As to the importance of rain warnings, Mr. A. P. Butler, of Fresno, the largest grower in the State, wrote the Daily Examiner, San Francisco, that, owing to the accuracy of the forecasts of the Weather Bureau, "not a pound of raisins has been lost in his vineyard during the season."

The Occidental Medical Times publishes the following statement:

The efficiency of the Weather Bureau on this coast has been greatly augmented, not only by the increased facilities for receiving data from a larger area of country, but also in the daily issuance and distribution of maps with the weather forecasts. Formerly reports were received only from stations of the Pacific coast and the country adjacent, but the field of observation has now been so broadened as to include much of the territory east of the Sierra Nevadas; consequently thermal waves which affect our climate secondarily can be better observed and their modifying influences predicted. This has rendered possible the announcement of approaching storms, both more accurately and for a longer period in advance than was possible before this system was adopted. Care has also been taken to properly diffuse the knowledge thus gained.

Commercial and shipping interests have been benefited at San Francisco by timely warnings of high winds, which have been published in general and special forecasts through the Merchants' Exchange and by the Board of Harbor Commissioners. Increasing the efficiency of the Point Reyes Station and the Government telegraph line connecting it with San Francisco has proved of very great value to maritime interests at the metropolis of the Pacific coast. During the past year the value of the vessels and their cargoes that have been saved from wreckage through the instrumentality of the Point Reyes Station would more than defray the expense of maintaining it, together with its telegraphic connections, for the next twenty years. The weather reports, received four times daily by telegraph at San Francisco from Point Reyes, are bulletined at the Merchants' Exchange and published in the leading shipping gazette of the city. These reports are closely watched by maritime people, especially those who are interested in traffic along the north Pacific coast. The display of storm signals on the northwest coast of California, the northwest coast of Oregon, and along the Washington coast during the "wet season" are acknowledged to be of much assistance to shipping. The trade in lumber, grain, and coal in western Washington and western Oregon requires large fleets of vessels in constant service throughout the year. They ply their vocation upon the waters of the Columbia and Puget Sound, and before departing for the ocean make close inquiries as to approaching changes of the weather off the Washington coast, which region lies directly in the path of storm movements from the Pacific.

The Morning Leader, Port Townsend, Wash., November 14, 1891, has the following:

The accuracy of the predictions of Lieut. Finley has made the Pacific coast branch of the national weather service of inestimable value to mariners, and of general interest to all people on the coast. When the office was first established the old sea captains would frequently laugh at the idea of predicting the condition of the weather in advance, but the accuracy with which Lieut. Finley has foretold of approaching storms time and again has taught the thoughtful mariner that it was no laughing matter, and now they invariably consult his reports before venturing out to sea. The absolute correctness of his predictions has been especially noticed by captains of sea tugs, who have to make frequent trips to the Cape, where the storms are usually the worst.

Communications received from the great lumber companies on Puget Sound acknowledge the benefits derived from the furnishing of storm warnings and general weather forecasts. Hundreds of loaded vessels have anxiously awaited the order "down signals" before going to sea, and their masters have admitted and appreciated the value of the warning. An important service has been rendered maritime interests at San Francisco by reporting by telegraph from Tatoosh Island, Clal-

lam Bay, and Port Angeles the arrival, departure, and passing of vessels, and also the state of the weather at these stations.

The recent organization of State weather services in Arizona, California, and Washington, coupled with those formerly established in Oregon and Nevada, has united all interested persons in systematic and useful coöperation with the National Weather Service. It has greatly encouraged voluntary meteorological observers, increased their numbers, and enlisted the sympathy and support of agricultural, commercial and educational societies and institutions. It has provided for the collection, publication, and dissemination of daily, weekly, and monthly weather and climatic reports, the value of which has been repeatedly admitted by the press and by the people.

The entire Pacific coast, with the western portion of the Plateau region, has responded with great heartiness to the development of the work of the Weather Bureau, and the press has afforded invaluable assistance in disseminating information and in instructing the public as to the advantages of coöperation with the National Weather Service. In no other part of the country have the railroads and telegraph companies given so much assistance in the collection and dissemination of weather reports.

No portion of the United States is more earnest in its appreciation or more active in its support of the highest development of the practical work of the National Weather Service. There is no better opportunity for high grade weather work. The rapid development of the Pacific Slope and the Plateau regions demands it. Questions of great moment to agricultural and commercial interests are beginning to arise, which will require the most careful investigation.

THE STUDY OF METEOROLOGY IN THE UNITED STATES.

In 1883 Dr. Frank Waldo, then in the employ of the U. S. Signal Service, presented a report on the extent to which meteorology was taught in the higher schools of Germany, Switzerland, and Austria, in which he refers to the growing need of trained meteorologists in this country, and says:

> We have a few men only who have made this subject enough of a study to be able to give instruction to young men. We have not more than two or three schools where there is any pretense of teaching meteorology, and even then the instruction is of a very elementary nature.

Of late, increased interest has been manifested in regard to meteorological education in the United States, chiefly, it is to be presumed, on account of the extension of the weather service of this country and of its practical applications. Young men of trained ability are in demand for the work of this service, and the increased distribution of weather maps and forecasts has drawn much attention to the subject. To enable the public to fully profit by the information thus conveyed, there is needed just such a widespread awakening in the matter as is now apparent.

I have repeatedly been asked within a short time past, both here and by letter from abroad, what is being done in our higher institutions of learning in the way of instruction in meteorology. To answer these numerous inquiries and to obtain definite information, which I am sure will be of general interest, I have, through the courtesy of the Commissioner of Education, caused a systematic examination to be made of

the college catalogues on file in his office, and the results are presented herewith. It should be borne in mind that the courses announced are in general of a somewhat elementary character. Original research and the work carried on by the trained meteorologist are usually freed from the restrictions of a class. In one case, however, which has come to my notice, admirable work of an advanced character is being carried on in class.

Following is a list of the universities and colleges announcing definite courses in meteorology. Such further information found in the announcements is given as is consistent with brevity:

California.—University of California, Oakland; John Le Conte, professor of physics. The physics of meteorology, lectures on the distribution of heat over the earth's surface, permanency of climate, distribution of rain, winds, etc., and on optical phenomena of the atmosphere. Twice a week during the second semester.

Colorado.—State Agricultural College, Fort Collins; Louis G. Carpenter, professor of physics and engineering. Meteorology is taken up for six weeks during the second term of the senior year, and includes a discussion of the instruments used in taking observations, barometry, thermometry, precipitation, the laws of storms, and the elements of agricultural meteorology.

Connecticut.—Yale University, New Haven, Conn. (Catalogue 1889-'90). A course in meteorology is given the seniors twice a week during the second semester. Loomis' Meteorology is used, with daily study of the current weather maps. In the Sheffield Scientific School of this university, in the course in agriculture, two hours per week (lectures) of the first half of the senior year are devoted to meteorology.

Florida.—Florida Agricultural College, Lake City. In the senior year, spring term, meteorology divides the time with logic, tactics, and astronomy.

Indiana.—Purdue University. In the second term of senior year of School of Agriculture meteorology is taught two hours a week for eight weeks.

Iowa.—Iowa State Agricultural College. Meteorology is given once a week in the second half of the senior year.

Kansas.—(1) Kansas State Agricultural College, Lake City. Physics and meteorology, two terms' work; text-books, Atkinson's Ganot's Physics and Loomis' Meteorology. This course also includes a careful study of instruments and methods employed in taking meteorological observations. (2) University of Kansas, Lawrence. Francis H. Snow, president and professor of botany, entomology, and meteorology. Meteorology: Loomis' Treatise and Lectures, one-half semester.

Massachusetts.—(1) Harvard University, Cambridge. William M. Davis, professor of physical geography. Meteorology: Lectures, recitations, written exercises, and laboratory work; three times a week during the first half year. A course of equal extent in physical geography follows during the second half-year. A second course in physical geography and meteorology consists of lectures and reports twice a week for a half-year. (2) Massschusetts Agricultural College, Amherst. Freshman year, fall term, climatology, or relations of weather and farming, two hours a week. (3) Massachusetts Institute of Technology, Boston. William H. Niles, professor of geology and geography. Climatology is taught by lectures and recitations twice a week for fifteen weeks of the senior year. The course is introduced with a general outline of meteorology, and in the physical laboratory the students have some practice with the ordinary meteorological instruments.

Michigan.—(1) Albion College, Albion. In the fall term a course of three hours a week in meteorology and the mechanics of the atmosphere is given in the department of physics. (2) Michigan State Agricultural College. R. C. Kedzie, professor of chemistry. A course in meteorology is given by lectures five times a week during the spring term of the senior year. (3) University of Michigan, Ann Arbor. A course in modern meteorology is given twice a week during the first semester; instruction is given by lectures, recitations, and practice in forecasting by means of weather maps.

Nebraska.—Doane College, Crete; G. D. Swezey, professor of natural sciences. Meteorology and mineralogy constitute a course given in the winter term (three months). In meteorology there is text-book work supplemented by observations with the instruments of the observatory, and by the tracing of weather changes from the United States weather maps.

New Hampshire.—New Hampshire College of Agriculture and the Mechanic Arts; Dartmouth College, Hanover. Second year, third term, Loomis' Meteorology.

New York.—Alfred University, Alfred Center; H. C. Coon, professor of physics. Gives a course of ten weeks in theoretical meteorology, and another of like extent in meteorology, theoretical and practical.

North Carolina.—Davidson College; H. L. Smith, professor of natural philosophy. Astronomy and meteorology are given three times a week in the senior year. After the 1st of March the class studies meteorology, and is taught to handle a full set of instruments for determining air pressure, temperature, moisture, rainfall, etc. Loomis is used as a text book.

North Dakota.—University of North Dakota, Grand Forks; Ludovic Estes, professor of mathematics, physics, and astronomy. Meteorology is taught one hour per week during the senior year of the scientific course. Loomis' Treatise, or an equivalent, is used.

Ohio.—Findlay College, Findlay; A. C. Redding, professor of chemistry and physics. In the fall term of the junior year meteorology is given in a course of lectures embracing atmosphere, winds, clouds, precipitation, theory of storms, atmospheric electricity, climatology, etc.

Oregon.—Oregon State Agricultural College. Meteorology is taught during the winter term of the junior year.

Pennsylvania.—(1) Pennsylvania State College. In the course in agriculture, meteorology (Abercromby's Weather) is given three times a week during the third term. (2) Washington and Jefferson College, Washington; James F. Ray, professor of physics and chemistry. Meteorology (Loomis) is taught during the third term of the senior year.

South Dakota.—University of South Dakota, Vermilion; Lewis E. Akely, professor of physics and chemistry. A course in meteorology is given two hours per week during winter term. Lectures and practical work.

Wisconsin.—University of Wisconsin, Madison; F. H. King, professor of agricultural physics. In the College of Agriculture a full course (five times per week) in meteorology is given during the fall term.

Wyoming.—University of Wyoming, Laramie. During the fall term of the College of Agriculture a course is given in meteorology and the use of instruments. The instruments are at the agricultural experiment station in connection with this college.

There are of course many institutions where more or less instruction in the elements of meteorology is given under some other name. In physics the topics of atmospheric pressure, vapor tension, condensation, and others, relate directly to this subject. It is not unusual for a chapter on meteorology to be added to a text-book of physics, and in a general course in physics of sufficient extent the subject may properly come in for its share of attention. In physical geography, also, no general course would be complete which did not include the subject of climatology and theoretical meteorology.

Besides the above named colleges, about twenty incidentally mention meteorology, usually as included in the general instruction in physics or in physical geography. Four have weather service stations in connection with them, and offer opportunities for practical meteorological work. Two or three other colleges announce their intention of soon including meteorology in their curricula.

It should be remembered that the Bureau is doing much in the way of popular education in meteorology by means of its maps and the work of individual employees, but allusion has been made to this elsewhere.

METEOROLOGICAL RECORDS.

The following brief sketch of the meteorological records of the United States, with particular reference to those filed in the Weather Bureau, is submitted for the information of the general public and students of meteorology.

Before entering in detail upon a description of the state of the records, it is deemed both appropriate and of interest in the present connection to present a brief résumé of the progress of statistical meteorology in the United States. Such a history must naturally differ but little, if any, from the history of statistical meteorology the world over. Here, as in older countries, much credit is due the private observer for his

untiring labor in recording facts which have contributed greatly towards the advancement of the science of meteorology. It is to private observers that we are indebted for such comparable records of the weather as were made during the early part of our country's history.

The distinction of being the first observer to make systematic record of the weather in the United States undoubtedly belongs to Dr. Lining, of Charleston, S. C., who, in 1738, eighteen years after the general distribution of the first comparable thermometer, began to maintain a record of temperature, to which precipitation was added in 1742. The Charleston observations, which were reported to the Royal Society of Great Britain, were followed by several other series in different parts of the country. The increase in the number of observers was, however, very slight. Up to the close of the eighteenth century there were but fifteen stations, so far as known, at which observations of temperature and precipitation had been made. From 1800 to 1817, which latter year may be said to mark the dividing line between systematic meteorology on the one hand and the unguided efforts of private observers without concert of action on the other hand, there was but little increase in the number of observers. Twenty-eight records have been transmitted to us; there may be still others in manuscript of which no public record has been made. Without any directing influence or medium of publication and exchange, it is not singular that so few records were made. Indeed, the wonder is that so many were kept.

The results of these observations as monthly mean values of temperature and total monthly precipitation are of record in the files of the Weather Bureau. Little is known of the originals.

What may be called the epoch of comparative or systematic meteorology in the United States begins with the efforts of Josiah Meigs, who as Commissioner of the General Land Office, issued a circular on April 29, 1817, requesting his subordinates (the several registers) to take regularly observations of temperature, wind, and weather. Meigs had previously failed to receive the sanction of Congress to a more elaborate plan of observation. He was without sufficient means to provide the more expensive apparatus; nevertheless he was still willing to do his utmost with the simple instruments at his command to secure comparative data for the study of atmospheric phenomena, and it is to be noted that with the data at his command he was able to recognize the area of several cold waves, although no clue as to their movement seems to have been discovered.

On his death, in 1822, the system which he established seems to have lapsed. No effort appears to have been made to compile the results of the observations made by the registers, nor is it known definitely what became of the original records of observation.

In treating of the meteorological observations made in the United States between the establishment of the Meigs system and the Signal Service, it will be convenient to divide them into two broad classes, viz, (1) those made by or under the directing influence of one or more branches of the public service, often as necessary adjuncts to the successful prosecution of work devolving upon them by law, and (2) those made by private individuals under the controlling influence of some central body or State organization.

Under the above heads, the observations made in connection with the work of certain branches of Government will be considered first. Foremost of these, both in point of time and in completeness, stands the series begun by Surgeon-General Lovell, in 1819. During the first few years of this series observations of temperature and wind direction were made

at 7 a. m., 2, and 9 p. m. In the year 1836 a rain-gauge was furnished to each post, and the daily fall of rain recorded in the register. No change was made in the hours of observations until January, 1841, when "sunrise" was substituted for 7 a. m. In 1842 the number of daily observations was increased to four, and the hours were "sunrise," 2 p. m., sunset, and 9 p. m. In 1843 the hours were changed to "a little before sunrise," 9 a. m., 3 p. m., and 9 p. m.

The results of the observations for 1820 and 1821 were published at the end of each year. Those of subsequent observations have been published in a series of army meteorological registers, of which the first volume, embracing the years from 1822 to 1825, inclusive, was issued by Surgeon-General Lovell in 1826. The second and third volumes of the series, comprising, respectively, the years from 1826 to 1830, and from 1831 to 1842, inclusive, were prepared and published, the former in 1840 and the latter in 1851.

With a desire to make the labors of the medical officers in the field of meteorology more useful in elucidating and defining the relations of atmospheric phenomena to the causation and development of disease, the Surgeon-General, in 1840 and 1841, applied to Congress for an appropriation to enable him to extend the system and make it more complete. With the funds appropriated for the purpose, he was enabled to equip a number of stations with barometers and hygrometers imported from Europe. The system thus extended went into effect January 1, 1843. It embraced four observations daily of the barometer, attached thermometer, thermometer (detached), clearness of the sky, direction and force of the wind, and the direction and velocity of the clouds. To these were added two daily observations of the wet-bulb thermometer and the measurement of rain and snow. Hourly observations of the barometer, thermometer, etc., were also directed to be taken for twenty-four hours at the equinoxes and solstices.

The results of the new series from 1843 to 1854, inclusive, except as regards observations of the barometer and hygrometer, were published in 1855. This volume contains the averages of temperature at each hour of observation and for the month, the monthly extremes of temperature, the number of times the wind was observed blowing from the N., NE., etc., and the sum of force from each direction, the average clearness of the sky, the number of fair days, the number of cloudy days, the number of days with rain, and the number of days with snow, and, finally, the amount of rain and melted snow. The system of wet-bulb observations was discontinued in 1849, having failed to give satisfactory results.

The hours of observation were again changed in 1855 to 7 a. m., 2, and 9 p. m., at which hours they were continued up to August, 1888. The last change was to one daily observation at 6 p. m.

The results for the period 1855 to 1859 were published in substantially the same manner as the period immediately preceding. Consolidated tables of mean temperature and total precipitation for each month and the four seasons, together with the annual extremes of temperature, were added to this volume (1855–'59).

From 1860 to 1874 the observations were turned over to the Smithsonian Institution and embodied in the reports of that institution, and later the entire series, both the original records and the office transcripts, extending from about 1860 (and in some cases earlier) to date, were turned over to the Weather Bureau.

Next in point of time to institute a series of meteorological observations was the Patent Office, which began to publish notes and memo-

randa of the weather some time in the decade 1840–'50. The Annual Report of the Commissioner for 1844 contains the following remarks:

An attempt has again been made to estimate the influence of the season by collecting notices of the state of the weather from the earliest periods in which the various crops could be supposed to be much affected by the diversity of the same.

And again in the Report for 1847:

It is not proposed to enter much into detail with respect to the weather. The space allotted to this portion of the report will not allow it. Still as the state of the crops is so immediately and mainly dependent on the aspect of the season, it would not be a fair exhibit of the influencing cause were we to leave this topic without notice. * * *

The foregoing remarks are given simply as indicating the trend of opinion at this period of our country's history. The Commissioner proceeds to further discuss the state of the season with respect to the condition of the crops, and follows with tables of number of days of rain, amount of rain in inches, mean temperature, all for April and May (grass season), and other statistics of like import.

Additional data were published each successive year; the volumes for 1855 and 1859, respectively, containing Joseph Henry's contributions, entitled "Meteorology in its Connection with Agriculture." Observations for the years 1854–'59, inclusive, were published as a Senate Executive Document, Thirty-sixth Congress, first session.

For the information of those unable to consult this volume, the following brief summary of its contents is given:

(1) The average height of the barometer reduced to 32°, but not to sea level.
(2) The maximum and minimum readings of the same instrument, with date of occurrence.
(3) The average temperature for the hours of 7 a. m., 2, and 9 p. m., and for the month.
(4) The highest and lowest temperature and date of occurrence.
(5) The warmest and coldest days as a whole.
(6) The average and maximum and minimum force of vapor.
(7) The relative humidity.
(8) The number of times the wind blew from each quarter.
(9) The amount of rain and snow.
(10) The average amount of cloudiness.
(11) Summaries for each year.

The results for each year are published separately. The annual reports of the Commissioner of Patents, and later the reports of the Commissioner of Agriculture, contain much climatic data extending from the beginning above noted to 1870.

While the Patent Office and the Smithsonian Institution were devoting a great deal of labor to meteorology as affecting land interests, the interests of the mariner were not neglected. The Twenty-ninth Congress appropriated, in 1847, the sum of $2,000 for the compensation of a meteorologist, and the next year $2,000 for "meteorological" observations to be conducted under the direction of the Secretary of the Navy. The services of Prof. James P. Espy were secured to discuss the observations and formulate his findings for the benefit of mariners. His several reports to the Secretary of the Navy contain the results of his investigations.

An important series of observations was begun under the direction of the Engineer Corps, U. S. Army, on the borders of the Great Lakes, in July, 1859, and continued with more or less interruption until 1876, there being but three stations in operation at that date. The greatest number of stations in existence at any time was fifteen. The results of these observations were in some cases published in the annual reports

of the operations of the Lake Survey. Transcripts from the originals are on file in the Weather Bureau.

The U. S. Coast and Geodetic Survey has also contributed to the general fund of information on meteorological topics. The results of the Survey's work will be found in Appendix No. 20, Report of 1875, "Meteorological Researches for the use of the Coast Pilot;" Appendix No. 10, Report of 1878, "Cyclones, tornadoes, and water-spouts;" and Appendix No. 10, Report of 1881, "Barometric hygrometry and the reduction of the barometer to sea-level," all by the late Prof. William Ferrel. Dr. William H. Dall, also of the U. S. Coast and Geodetic Survey, has collated and published in the Pacific Coast Pilot all meteorological observations of record for Alaska and the Bering Sea region, to which he has added a number of charts and a discussion of the observations. This collection embraces tables of atmospheric pressure, mean temperature of the air, sea temperatures, average precipitation, and prevailing direction of the winds, and other data.

The second general head embraces all observations made by private individuals, and forwarded at one time or another to the Smithsonian Institution, those made in direct coöperation with that institution, and those made by State systems which were later gradually merged in the general system of the Smithsonian Institution.

The State of New York can properly lay claim to establishing the pioneer State weather service. In 1826 the university regents of New York directed that each of the academies under their jurisdiction should be furnished with a thermometer and a rain-gauge, and that the diligent report of observations should be an essential condition of their receipt of State funds. Further instructions from time to time directed observations of the wind and a variety of miscellaneous occurrences, considerable attention being directed upon phenological phenomena. The observations began in 1826, and were continued more or less completely until 1850. During this period sixty-two academies reported observations, of which three were complete for a whole term, and only three quite failed to record the precipitation. In 1849 the legislature made an appropriation for the purchase of improved instruments, in order to conform the State system of observations with the more comprehensive system recently instituted by the Smithsonian Institution. A small sum was appropriated for salary of observers. The instruments provided by this appropriation were a mountain barometer, thermometer, rain and snow gauge, wind-vane, and, to a few stations, wet and dry bulb thermometers. The system came into operation at the end of 1850, and thirty-five academies began the observations. From the first the humidity observations were a failure, owing to confusion of reduction tables and thermometric scales. In 1863 the legislature failed to make the small salary appropriation, and from that time the system rapidly declined, both from that cause and from the great weight of the Smithsonian observations covering the same ground. The reports of these observations were published in the annual reports of the regents from 1826 onward. In 1855 the observations from 1826 to 1850 were collated and published, and in 1872 appeared a similar collation of the second system of observations from 1850 to 1863.

Pennsylvania next became interested in the study of atmospheric phenomena. The legislature of that State, in 1837, appropriated $4,000 to equip one station in each county with a barometer, two thermometers, and a rain-gauge. As many as twenty-two stations reported under this system, but it lapsed as a distinct organization in less than

ten years. Some of its observers, however, continued their work under the auspices of the Smithsonian Institution.

The published results of these observations will be found in the transactions of the American Philosophical Society and the Franklin Institute.

Mr. Lorin Blodgett, of Philadelphia, whose knowledge of the climatology of the State amply fitted him for the work, has compiled a set of climatic maps, one for each month, showing average temperature and precipitation for the State.* The more important temperature and precipitation records (monthly values only) have been published in the report of the secretary of internal affairs for Pennsylvania, 1888.

In 1849 the State of Massachusetts inaugurated a system of meteorological observations, which, in a year or so, was merged with the more elaborate system of the Smithsonian Institution.

The Smithsonian Institution began its great work in the field of American meteorology in 1849 along several parallel lines of research, which appear topically as record of observations, publication of material aids to meteorological study, and forecast of approaching weather conditions. As a bureau of record the Institution, under the direction of Joseph Henry, gathered up from all sources past records of observations, assisted the few systems of observations then in existence, and instituted its own system throughout the country. Before this time the records, if published at all, appeared in most cases without corrections or reductions, and very rarely were they discussed. But the Smithsonian was in a better position than any other organization to give the rapidly accumulating data scientific treatment, and for that reason the data of other systems were at first sent to the Institution for examination, as was the case with the Patent Office series, and by natural growth the individuality of the several independent series was for greater convenience merged in the Smithsonian. Thus it came about that, in 1870, this great Institution controlled all the meteorological records of the country.

With the organization of the Signal Service, in November, 1870, the meteorological service of the country was provided for by the General Government. The efforts which the Smithsonian Institution had previously made in the establishment of meteorological stations were therefore discontinued, and soon after the Signal Service had entered fully upon its duties the active support of the Smithsonian Institution was withdrawn. The efforts of the Signal Service were largely taken up in the development of a system of weather predictions, and thus it happened that the climatological work, so ably prosecuted by its immediate forerunner, was in a great measure subordinated to weather forecasting. The number of voluntary coöperating observers decreased steadily, so that in 1887 the total number of observers was but 378. The number has increased very rapidly since that date, however, and aggregated on June 30, 1891, when the Weather Bureau was transferred to the Department of Agriculture, 2,028. The net gain during the five months just passed has been greater, it is believed, than at any other period in the history of the Bureau, being 191.

Having thus traced the development of meteorological observations in the United States, it now becomes of interest to know where and how far the results of said observations are available for the many purposes for which they can be used.

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* These maps may be found in the Transactions of the Franklin Institute, Philadelphia, Pa.

THE USE OF OUR DATA.

The enormous accumulation of meteorological records now in the Weather Bureau affords an opportunity for climatal and other special studies and investigations, which should be utilized to the greatest degree possible. We have now the observations for the twenty years during which the meteorological work was in the charge of the Signal Service and also those for many years before, when in charge of the Smithsonian Institution. I propose to utilize these data by special studies by the proper officers of the Bureau. Several studies of this sort are now under way and others are being organized. But I believe that we should pursue no exclusive policy in the treatment of our records. They should be thrown open to all students of meteorology who are competent to use them, subject only to such restrictions as will preserve them from injury. I recommend that meteorologists be invited to make use of them in the Bureau. Space can be found for a limited number of such students and the necessary guidance and oversight given them.

A brief statement of the records embraced in the files of the Weather Bureau follows:

(1) The records of Weather-Bureau stations which have been in operation since November, 1870. Of such stations, 373 have been in operation at one time or another. Main dependence is of course placed upon these observations.

(2) The records of the Medical Department of the Army from 1860 to date, and the reports of voluntary coöperating observers from December, 1873, to date.

(3) As a special deposit, the records collected by the Smithsonian Institution from 1847 to 1873. This collection embraces original registers or monthly values of temperature and precipitation secured through the coöperation of the United States Lake Survey, under the Engineer Corps, U. S. Army; the U. S. Coast Survey, under the Treasury Department; the compilations of Dr. F. B. Hough from observations made under the direction of the regents of the University of the State of New York, the records made in Pennsylvania under the direction of the Franklin Institute, of Philadelphia, the transactions of various societies and periodical publications.

(4) Abstracts of monthly registers forwarded by directors of State weather services and meteorological societies.

(5) Abstracts of reports made by the Central and Southern Pacific railway agents.

(6) Records of observations at stations of the Canadian meteorological service, furnished through the courtesy of the director.

(7) Copies of many private series of observations, the originals remaining in the custody of the owners.

The condition of the records, with reference to the facility with which the data contained therein can be supplied to the public, will be considered below.

The different elements, as temperature, precipitation, etc., will be taken up separately. The word "compiled," as used throughout this report, has a certain restricted and definite meaning, to wit, that the data under consideration—as, for example, monthly averages of temperature—have been abstracted from the original reports, entered upon specially prepared forms, having, as a rule, the months of the year running horizontally across the top of the page and the years in a perpendicular line on the left-hand margin. The sums and means are generally, but not always, computed and entered at the bottom of the page.

It should also be remembered that when charts are mentioned the edition is limited, unless otherwise stated. Copies, however, can always be consulted at the office of the Chief of the Weather Bureau or at stations of the Bureau outside of Washington. The edition of the Monthly Weather Review is limited; but few copies can be secured, unless special arrangements are made beforehand.

An "Index of Meteorological Observations in the United States" has been prepared, and will shortly be sent to the principal stations.

This index will afford persons inquiring after climatological data an idea as to the number and character of records made in the several sections of the country.

TEMPERATURE.

More attention has been given to compiling temperature and precipitation data than to all of the other elements combined, since the temperature and rainfall of a place are the two climatic features which most forcibly impress themselves on the average man, and, moreover, it is with these two elements that the majority of investigations as regards the relations between weather and crop production must deal.

Daily values.—The daily extremes of temperature from self-registering thermometers for 145 Weather Bureau stations from June, 1872, or the establishment of the station when opened subsequent to the above-named date, to December, 1890, can be supplied with readiness. A set of charts has been prepared, showing for each decade of the year (three decades to a month) the highest and lowest temperature reached therein from the beginning of the record to June, 1891.

Daily readings at the several hours of observation.—These have not been compiled, but must be sought for in the original reports.

Temperature averages, daily.—Daily averages for a fifteen-year period ending with 1885 have been compiled for Weather Bureau stations only.

Temperature averages, five-day periods.—Steps have been taken to have compiled at stations of the Weather Bureau and at the central office normal temperatures for five-day periods after the international plan. It is hoped to have these data completed by July 1, 1892.

Temperature averages, ten-day periods.—Averages for ten-day periods at the hours of 8 a. m. and 8 p. m., seventy-fifth meridian time, have been compiled, and are used chiefly as adjuncts to the work of the forecast room. Charts have also been prepared.

Temperature averages, monthly.—Monthly averages of temperature for about 5,200 stations in the United States and 300 in the Dominion of Canada have been compiled in one or more volumes for each State or Territory. These data can be furnished quite readily, the only labor required being the simple copying, which, for a twenty-year record, will not take more than twenty-five minutes. The length of record varies from a single month to one hundred and twenty-five years. The average length of record will probably not exceed five years. For the information of those wishing to keep informed as to the temperature conditions which obtain in different portions of the country from month to month, it may be stated that the Monthly Weather Review contains, in addition to the charts named below, tabulated data of the average, the highest, and the lowest temperature for the month for about 2,000 stations. Charts of the monthly and annual mean temperature are published in the Monthly Weather Review. The annual report of the Chief of the Weather Bureau will also contain, it is expected, tables of monthly means and extremes of temperatures, and the annual range.

Monthly means of maximum and minimum temperature.—These data have been compiled for an eleven-year period, beginning with 1880, and can be furnished readily.

The difference between the mean maximum and mean minimum for any month gives what is known as the mean daily range. These data have been compiled for a period of twelve years for the principal Weather Bureau stations.

Extremes of temperature, monthly.—The monthly extremes for 373

stations of the Weather Bureau, including the stations not now in operation, have been compiled, and can be furnished readily.

Temperature variability.—The temperature variability, obtained by noting the changes in mean temperature which take place from one day to another without regard to the course of the temperature, whether rising or falling, has been compiled for a period of about ten years at the principal Weather Bureau stations, and can be readily furnished. These data are of value to physicians and others who desire to know the degree of equability of temperature experienced in various portions of the United States. In addition to the foregoing-named records of temperature, note should be made of the automatic records which have been accumulating from 23 stations since June, 1888; additional stations have been furnished self-recording thermographs since that date. The number now having such instruments is 73. The data of hourly temperature thus becoming available will soon be of sufficient value to warrant an examination, more in detail than has been possible heretofore, of the interesting features connected with the daily march of temperature. The results thus far accomplished under this head will be found in the publication entitled "Mean Temperatures and Their Corrections," by Alexander McAdie, A. M.

PRECIPITATION.

As in temperature, the compilations of precipitation data embrace the records of a large number of stations, including observations from the earliest times to the present day. The number of stations for which a record of precipitation has been compiled is about 5,500 in the United States and 350 in the Dominion of Canada.

Daily amounts.—The daily precipitation at 145 stations of the Weather Bureau, from the beginning of the records in 1870 to date, has been compiled on specially prepared sheets. The daily precipitation at about 300 special rainfall and voluntary stations for irregular periods has also been compiled.

Monthly totals and averages.—The monthly totals of precipitation for the whole number of stations for which records have been made (5,850) have been compiled and entered in specially prepared volumes, one or more volumes to each State or Territory. The monthly totals for any station or number of stations can be furnished with but little labor; not more than thirty minutes will be required to copy a twenty-year record.

The greatest and least monthly falls for Weather Bureau stations can also be supplied quite readily. Charts and tabulated data of monthly and annual precipitation for about 2,000 stations will be found in the current issues of the Monthly Weather Review.

Normal rainfall of the United States.—The normal rainfall of the United States, as shown by eighteen years' observations, will be found in a special publication, entitled "Charts showing the Monthly Normal Rainfall of the United States," etc. This publication contains the numerical values and charts for each month of the year.

Excessive precipitation.—The number of rainfalls of 10 inches and over per month, and the number of occurrences of 2.50 inches in twenty-four hours, or of 1 inch in an hour, from eye records beginning in 1870 and extending to date, can be supplied for Weather Bureau stations only. Automatic records of rainfall began in April, 1889, at 6 stations; the number of such stations now reporting is 34. The data of excessive rainfalls afforded by these instruments, and also given in a certain degree by the eye records of beginning and ending of precipitation which

have been maintained at all Weather Bureau stations from November, 1870, to date, are valuable, especially to engineers charged with the construction of sewers, reservoirs for irrigating purposes, etc. Data of excessive precipitation have been applied to a number of engineering problems during the past few months. Applications from municipal authorities for information as to kind and cost of automatic gauges show that the importance of the subject is being realized by cities entering upon the construction of extensive water works.

Rainy days, number of.—The number of days on which 0.01 inch or more of precipitation has occurred during each month of the year from the establishment of the stations to date has been compiled, and can be supplied for Weather Bureau stations quite readily. The mean annual deviation or variability of precipitation as expressed by the percentage which the annual excess or deficiency bears to the normal has not been deduced, neither has the diurnal periodicity been calculated, except for a few stations. Charts showing the probability of rain for each month of the year have been prepared.

SNOW.

The records of snowfall are not as complete as might be wished. The total depth in inches for each month of the season is given at the majority of Weather Bureau stations for 1884–'85 and at all stations thereafter. Charts of depth of snow on the ground at the end of the month have appeared in the Monthly Weather Review regularly since November, 1888. Data of monthly snowfall have not been collated so as to be readily supplied to inquirers, although the number of requests for such data have increased of late years. The manufacturers of rubber goods, especially foot wear, are much interested in snowfall statistics, inasmuch as it appears that the demand for rubber overshoes, boots, and the like is regulated by the quantity and prevalence of snowfall.

ATMOSPHERIC PRESSURE.

Observations of atmospheric pressure have been made at about 900 stations in the United States. Of this large number but comparatively few stations outside of those maintained by the Weather Bureau have given records which can be utilized in a comparative study of storm movement. Owing to the fact that the greater portion of the observations were purely voluntary, and that frequently no accurate determination of the elevation of the stations could be had, there has been little uniformity in the matter of reductions. Some observations have not been reduced to 32° F., and in the great majority of cases no corrections to reduce to sea level have been applied. The record of pressure observations at stations of the Weather Bureau prior to 1873 is not satisfactory, owing to a number of causes.

Hourly readings.—Hourly eye readings have been made for very short periods at the mountain stations of Mount Washington, N. H., Mount Mitchell, N. C., and Pike's Peak, Colo. These have been printed in the annual reports and special publications of the Signal Service. Hourly readings were also made at a number of Weather Bureau stations, during the day hours only, for three months in 1888, and also for a year (twenty-four hourly readings) at Washington, D. C. Automatic hourly records are now being made at fifty stations of the Weather Bureau. Such records were begun at five stations in October, 1888. The observations formerly made by the Signal Service include readings

of the barometer seven times daily. The data have not, however, been compiled.

Highest and lowest barometer during the month.—The highest and lowest barometer for each month of the year for a period of nine years (1880–'88), reduced to 32° F. and to sea level, have been compiled and entered in specially prepared books. Charts of normal monthly pressure (reduced) at 8 a. m. and 8 p. m., seventy-fifth meridian time, have been prepared for use of the officials of the Weather Bureau. They can be consulted, when reproduced, at the office of the Chief of the Weather Bureau in Washington and at Weather Bureau stations.

Average monthly pressure (at 7 a. m., 3, and 10 p. m.), Washington mean time.—The average monthly values reduced to 32°, but not to sea level, for the hours at which observations were telegraphed to Washington from 1873 to 1887 have been compiled and can be supplied readily. Monthly averages for each month of the period 1873–'87 have not been calculated. Steps have been taken to secure a continuous record of the average monthly pressure at each station of the Weather Bureau from the opening thereof to January, 1890; all pressures to be reduced to the datum point in use on that date. The numerical values of monthly and annual pressure (actual and reduced) are published in the Monthly Weather Review, a chart of reduced pressure appearing in each issue. For the daily pressure one must look to the daily weather map. The phenomenon of diurnal variation of pressure has been investigated to some extent with the data available. Curves of daily fluctuations have been drawn for a number of stations, but it has not yet been found advisable to reproduce them. The results of the work thus far accomplished will be found in the publication "Diurnal Fluctuations of Atmospheric Pressure at twenty-nine selected stations in the United States."

WIND.

The files of the Weather Bureau contain observations of the wind at over 2,000 stations. As in other elements, a lack of uniformity in the hours of observations at very many of the voluntary stations is noticeable. Generally tri-daily observations at 7 a. m., 2, and 9 p. m. were made. The Medical Department of the Army noted the direction of the wind three and for quite a period six times daily. The results of these observations from 1821 to 1860 are available in the published reports of the Department, as before noted; the original records from 1860 to date are in the possession of the Weather Bureau, but no compilation of the data has been made.

The results of the voluntary system of observations up to and including 1869 are included in Prof. Coffin's compilation, "Winds of the Globe."

The following compilations of wind data (direction) for Weather Bureau stations have been made, and are in convenient form to be readily supplied to the public.

Number of times observed blowing from the N., NE., etc., as noted at the tri-daily telegraphic series of observations for each month of the year from 1871 to 1888, and the prevailing direction as deduced from the data so recorded. The direction of the wind as given by automatic records has been compiled for a few stations having automatic recording instruments. The results, however, are not available for distribution. Automatic records of the direction of the wind are now being received from 53 stations.

The Monthly Weather Review contains charts and tabulated data

showing the prevailing direction of the wind for each month of the year.

A special series of charts have been prepared for use of the officials of the Weather Bureau, showing the prevailing direction of the wind at the morning and evening hours of observation at the principal points of observation east of the Rocky Mountains. These charts may be consulted at the central office in Washington and at stations of the Weather Bureau.

WIND VELOCITY.

The continuous records of wind velocity in the files of the Weather Bureau are without parallel as regards number of records or continuity. The records at the older stations began in 1872 and are continuous to date.

Average hourly velocity.—Average hourly velocities for about 65 representative stations have been calculated for each month of the year, and published as Appendix No. 14 to the Annual Report of the Chief Signal Officer for 1890. These data can be supplied to the public quite readily.

Total monthly wind travel.—The monthly wind travel, 1871 to 1888, for all Weather Bureau stations has been compiled in specially prepared volumes for ready reference.

Maximum velocity of wind for each month.—The maximum velocity of the wind during each month of the period 1871–'88 has also been compiled as above. Special charts showing the average *hourly* velocity of the wind for the hours ending at 8 a. m. and 8 p. m., seventy-fifth meridian time, respectively, and the average highest and lowest hourly velocity during the day for each month of the year, have been prepared for use of officials of the Bureau.

HUMIDITY.

Observations of the wet and dry thermometers have been made at about 750 stations in the United States. It is doubtful, however, if the majority of such observations will afford at best more than a close approximation to actual conditions. The New York Academy system, after thirty-five years' experience, accomplished but little. The Medical Department, after twelve years' observations, replaced the instruments in use during that period with others which it was expected would yield better results. The examination of hygrometric observations made under the voluntary system, so far as it has gone, shows the results to be unsatisfactory, as a rule.

This is regretted, inasmuch as several very important inquiries have within the past year or so been set on foot respecting the relative dryness of several portions of the country.

The hygrometric observations of the Weather Bureau were for a long period made in window (unventilated) shelters. The present form of shelter, adopted in 1885, together with the apparatus for whirling the thermometers, yields quite accurate results.

The values of relative humidity deduced from the present series of observations (8 a. m. and 8 p. m.) are not strictly comparable with the results derived from tri-daily observations, one of which was taken during the heated portion of the day.

Monthly averages.—Monthly averages of relative humidity for each month and all years from 1871 to 1888 have been compiled and can be supplied quite readily. No daily values have been collated. The absolute humidity has not been calculated except for one year (1883).

DEW-POINT.

A record of the dew-point has been made at the Weather Bureau stations since July, 1881. Monthly averages are of record and in convenient form for reference.

CLOUDS.

Record of the amount, kind, and direction of clouds for upwards of 300 stations of the Weather Bureau are on file in the original manuscript reports. No compilations have been made except as to amount. *The average monthly cloudiness*, on a scale of 0-10 determined from three eye observations per day from 1871 to July, 1888, thereafter from frequent personal observations during the day for the majority of stations, has been compiled. Twelve monthly charts have been prepared.

Automatic sunshine recorders have been in operation at about twelve stations since the early part of 1890. Many of the records at first produced were faulty, but the tendency towards better results has been apparent for some time. Twenty stations are now supplied with automatic recorders.

Cloud observations are also of record for about 2,000 voluntary stations. A lack of uniformity is noticeable in these observations, as in other elements, some observers giving only amount and direction, others kind and amount, and still others kind, amount, and direction.

No compilation has been made of the cloud data afforded by the voluntary system of observations.

WEATHER.

The number of *cloudless*, *partly cloudy*, and *cloudy days* for all months of the period 1871 to 1890 has been compiled in specially prepared volumes.

A cloudless day is one having an average of less than three-tenths clouds; partly cloudy, three to seven-tenths; cloudy, eight to ten-tenths.

A number of minor compilations have been made from time to time. It is believed, however, that but few of them would be of special interest to the general public.

Special reports have been made to both Houses of Congress on the questions of water storage and irrigation, rainfall of the Pacific slope and the western States and Territories, and on the climate of Oregon, Washington, and Nebraska.

A year's observations on evaporation have been printed and discussed, and reports have been made on a number of other subjects, due notice of which has appeared in the publications of the Bureau.

THE LIBRARY.

The work of the library falls into two distinct classes, (1) the collection, cataloguing, and arrangement of the printed literature relating to the weather and its various relations, and (2) the preparation of an index to this literature for the use of those having occasion to consult such works as the library contains relating to the subject under investigation, and also the preparation of a classified catalogue of the whole literature of meteorology, in order to present readily what has been done by investigators all over the world in certain lines of work, and to show where the results of these investigations may be found.

The library at present contains about 12,000 books, exclusive of pamphlets, relating mostly to meteorology, climatology, electricity, and magnetism, with some reference books and books on general science. They are arranged according to a simple scheme of classification, and are fully catalogued under authors' names and again under the subjects, thus facilitating ready reference.

Additions to the library are obtained by purchase and by a system of exchange of publications. Foreign weather services receiving the publications of the Weather Bureau send in return their own publications, and in this way a most valuable series of results of observations and investigation are accumulated and made available for comparative study. The collection of weather maps and bulletins thus obtained is especially valuable for comparative study in weather forecasting; practically complete sets of sixteen foreign weather services being now in the library bound in volumes convenient for reference. Some of the more valuable sets, covering long periods of daily maps, are here given: France, from 1863 to date; United States, from 1871 to date; England, from 1872 to date; North Atlantic and Europe, from 1873 to 1876 and from 1880 to 1886; Germany, from 1876 to date; Austria, from 1877 to date; Algeria, from 1877 to date; Belgium, from 1877 to date; Japan, from 1883 to date.

In accordance with the expressed purpose of Congress to develop the work of the Bureau in the interest of agriculture, especial attention will be given to the collection of the literature which is now so extensively issued by the State weather services and the agricultural experiment stations, and all publications containing climatic data relating to the various States, in order to facilitate the study of local climate in this country.

As it is the desire of the chief of the Bureau to make the valuable collection of printed literature of meteorology and climatology in the library useful to the fullest extent, the privileges of the library are extended to private investigators in any part of the country under such restrictions only as will insure the careful usage and safe return of the volumes loaned.

INDEX TO METEOROLOGICAL OBSERVATIONS.

The index to all observations made and recorded in the United States and accumulated in the Records Division of this Bureau has been of great value since its completion a year ago, under the direction of General Greely. The very valuable collection of foreign observations in the library, covering every portion of the globe and extending over long series of years in many instances, has thus far had no suitable index beyond the usual cataloguing of the volumes as they are received into the library. The usefulness of such a collection is vastly increased by the possession of an index such as that made to observations in the United States.

The frequent calls made upon the librarian by the Records Division for climatic data in foreign lands impressed upon him the importance of having prepared a complete index to all foreign meteorological data, arranged in alphabetical order under the names of the places of observation. Such an index has been begun in the library, with the coöperation of the Records Division. In its final form the index will consist of a large number of cards; each card will contain a fairly complete history of a station, giving all the information, in tabular form, which is likely to be called for, together with a reference to the

publication in the library in which all this information may be found. For example, each card will contain the name of a station, its latitude and longitude, its elevation above sea-level, the character and frequency of the observations made at the station, the date of begining and ending of each series of observations, and the reference to the book in which this information is printed. The meteorological history of any station on the globe of which there is any record in the library collection may thus be placed before the inquirer as quickly as a place may be looked up in a gazetteer.

This index to foreign observations has been in preparation for about two months, and the first draft completed for India, the East Indies, Australasia, China, and Japan, making available for ready reference histories of over 5,000 stations, each station possessing a series of observations extending on an average over a period of about twelve years, while the periods range in extent from one year to eighty years.

To the central office the value of the index, when completed for the entire globe and put into the form of a card catalogue, can not easily be overestimated. Much time will be saved which is now spent searching for records, while climatological research will be stimulated when it becomes known that there is such an index, and that access to the records in the library is allowed, under necessary restrictions, to all students of meteorology competent to use them.

GENERAL CATALOGUE OF METEOROLOGY.

It is generally recognized that one of the most useful indirect aids in scientific research is a catalogue which will show what has been accomplished in the science.

At an international meeting of delegates, representing the various meteorological services of the world, held at Rome in 1879, it was resolved to request the delegates to urge upon their governments the importance of preparing national catalogues embracing all observations and works relating to meteorology and published in their respective countries. As this recommendation was not acted upon, General Hazen, then Chief Signal Officer, recognizing the importance to the Bureau of a general catalogue of all the important meteorological publications, purchased the catalogues of two private individuals, which yielded nearly 30,000 titles. These formed the basis of a general bibliography of meteorology.

Representatives of the various foreign weather services promptly and very generously responded to General Hazen's request for assistance in the compilation of the catalogue, with the implied understanding that the work was to be completed as an official matter, and, if possible, published by the Signal Service. From 1884 to 1887 the collection of material was vigorously prosecuted. At the end of this time the number of titles on hand was about 50,000, covering the period from the origin of printing to the close of 1881. The catalogue includes all the more important contributions to meteorology, climatology, and electricity and magnetism brought to light by a careful search of the principal libraries of the world and examination of accessible catalogues. After thorough examination of the titles, they were arranged according to a carefully planned system of classification.

About half the material accumulated has come from foreign meteorologists, mostly from those who have voluntarily contributed much valuable time, and whose chief reward thus far has been a hope that they may some day receive a printed copy of the completed work,

General Hazen was unsuccessful in his efforts to secure an appropriation for printing the catalogue. His recommendations to Congress were renewed by General Greely in his annual reports when the latter became Chief Signal Officer.

In his report for 1887 General Greely strongly indorses the importance of this work as of great practical value in the current work of the office and to meteorologists in general. As long as this material remains in its present form of a card catalogue it is of value mainly to this Bureau. Its publication would not only vastly increase its usefulness by placing copies within the reach of those now actively engaged in climatological studies in all the States of the Union, but it would remove the moral obligation resting upon this Bureau to make every effort to have copies of the complete catalogue made accessible to the foreign services and individuals who so generously assisted in its preparation.

Since 1887 more than 10,000 titles have been added to the general catalogue, and the period covered has be enextended from 1881 to 1889.

In order that the most important parts might be made more generally available and to insure the safety of the catalogue, which has cost much time and effort in its preparation, a few copies of portions of the catalogue were reproduced by lithography and the milleograph process, under the direction of General Greely. These were distributed to the prominent libraries of this country and to foreign contributors to the work.

Progress in meteorological and climatological study has undoubtedly been retarded many years owing to the absence of a general index to the literature of these subjects. It is hoped that in view of the value of this catalogue as a time-saving device, if made widely and easily accessible, means may be found for its publication in proper style at an early date.

INSTRUMENTS.

The great tendency of the genius of modern times has been to devise and invent instruments and mechanisms that shall not only do all manner of work, but also very often do it much better than could be done by hand. This is as true in meteorology as in any other field of study, and to-day the greatest variety of ingenious instruments are in use for securing records of the various conditions of the atmosphere about us that go to make up the climate of a place. To ascertain this climate we must have continuous records hour after hour and day after day of all the meteorological elements. This is what the instruments secure for us. It will not be possible here to give a description of even the more important of these ingenious instruments, but since rainfall and sunshine have such a direct and immediate influence upon all plant growth and are of such importance to agriculture, brief descriptions of one or two forms of instruments for this purpose will doubtless prove of interest.

In the first place it may be said that the amount of rainfall is nearly always expressed, not in so many quarts or gallons or barrels, but in so many inches or so many hundredths of inches of rainfall, which means that if none of the water runs or soaks away the surface would be covered so many inches with water. As the rainfall is often only very light—that is, only a few hundredths of an inch—it may be wondered how such small quantities can be measured accurately. This is easily understood from what follows.

Suppose a large metal basin a foot or more in diameter be exposed to

collect the rainfall. Ordinarily the water thus collected would be only a small fraction of an inch deep and difficult to measure accurately. If, however, the bottom of the vessel, instead of being flat, be shaped like a funnel so that all the water falling within the basin may be conducted into a smaller vessel, such as a tin cup underneath, we see at once that the depth of the water will be greatly magnified. If the area of the basin is ten times that of the cup then water 1 inch deep in the cup would mean only one-tenth of an inch of rainfall. This principle is always applied in the construction of rain gauges. Such an instrument tells only how much rain fell and gives no idea as to *when* it rained or whether it rained very fast or gently.

By aid of the accompanying drawing (Fig. 1) it may be seen this additional information may also be obtained:

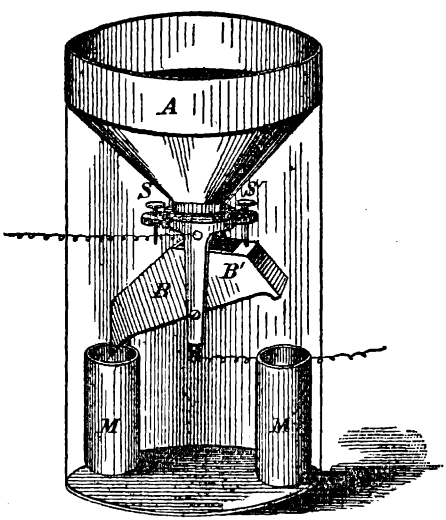


FIG. 1.—Recording rain gauge.

The large receiver *A* of the rain gauge has its bottom shaped like a funnel, and just beneath this is suspended a kind of three-sided bucket which has a partition across the middle portion so as to divide it into two equal parts, *B* and *B'*. This bucket is delicately supported upon an axis or hinge so that it can be tipped back and forth. The arms *S* and *S'* project out and prevent the bucket from tipping too far. Now, when water trickles through the funnel it is caught in the bucket, but this latter is so made that it will hold only so much water as represents, say, one one-hundredth of an inch of rainfall. When this amount has run into it, the bucket becomes top-heavy and tips over against the arm *S'*, the water at the same time running into a tall cylinder, *M*. In the new position of the bucket the side *B'* is presented underneath the funnel so as to receive the water, and when full also causes the bucket to tip. Of course, if the rain falls very rapidly the bucket will tip from side to side in rapid succession, while for very gentle rain a considerable time may be required before the bucket becomes full enough to tip. It remains now to show how it is possible to secure an automatic record of the number of times and the frequency of the tips of the bucket. That wonderful agent, electricity, useful in so many ways, serves admirably in this connection. A small spring is arranged in such a way that when the bucket tips the spring is momentarily deflected and made to close an electric circuit through wires by which the rain gauge is connected with an electric battery and the recording part of the apparatus. This recording part or register consists of a clock movement, to which a cylinder, having its surface covered with a sheet of paper, is joined in such a manner as to be turned round and round quite slowly by the clock. A pen or pencil attached to a suitable arm is mounted beside the cylinder and pressed gently against the paper so as to trace a mark as the cylinder moves under it. Moreover, the arm to which the pencil is attached has a piece of iron attached to it in such a manner that

whenever the bucket of the rain gauge tips and the electric current is made to flow, as explained above, the iron will be attracted by a magnet, thus drawing the pencil aside momentarily and making a corresponding mark upon the paper, each mark representing a tip of the bucket. The sheet of paper is divided off by lines into hours and minutes, so that we can tell exactly when the tips of the bucket occurred and how fast the rain fell at the time.

For recording sunshine a number of different instruments have been devised. The one shown in Fig. 2 is in use at several of the stations of the Weather Bureau. It consists of a metallic cylinder supported upon a frame so that it can be set up in an inclined position. This places the cylinder so that the sun shines as nearly as possible squarely against it during the whole day, both forenoon and afternoon.

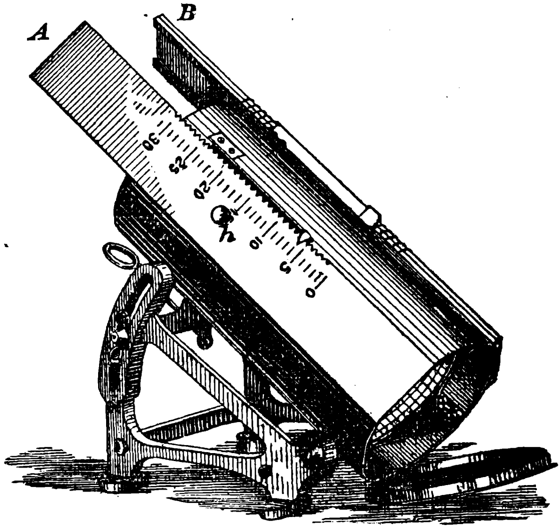


FIG. 2.—Sunshine recorder.

Two slides, *A* and *B*, are attached to the cylinder at two places and are provided with notched edges and springs so that the slides can be set in a number of different positions. In fact, a notch is provided for each day of the month, and when the instrument is in use the slides are set into a new notch for each day of the month. A long slot is cut underneath each slide, and in the middle of each slide just above the slot is cut a very small hole beveled out upon the upper surface. The beveled portion of this hole is seen at *h*. In setting up the instrument one of the slides is made to face toward the forenoon sun and the other toward the afternoon sun. Looking at the lower end of the cylinder, which is shown open in the figure, a small portion of two curved surfaces can be seen within. These surfaces extend from end to end of the cylinder, and against them are placed the sheets that are to receive the record, each sheet facing directly towards its corresponding slide. When sunshine falls upon one or the other slide a small beam of light passes through the small hole and falls in a bright spot upon the paper opposite. This paper has a peculiar chemical spread over its surface, and whenever the sunshine falls upon it the chemical undergoes a change. Afterwards, when the paper is taken out and washed in water, the parts that were affected by sunlight all turn blue while the remainder of the paper washes out nearly white. As the sun passes across the sky from hour to hour the little spot of light passes across the sheet, tracing what will afterwards become a blue line, which will be continuous if the sun shines steadily, but will be broken and interrupted whenever the sun is obscured by passing clouds. The slide being moved each day brings the spot of light to a new place upon the

sheet, and in this way a continuous and automatic record of the amount of sunshine from month to month can be procured.

METEOROLOGY AND TERRESTRIAL MAGNETISM.

These have long been studied side by side, with the object of discovering some physical relations connecting the two classes of phenomena pertaining to them, but such efforts have been on the whole fruitless. Hence these subjects are now generally separated from each other, and are regarded as distinct branches of science.

The researches carried on by Prof. F. H. Bigelow have, however, given rise to the hope that after all there may be some bond between them existing in nature, which has been missed in the discussion of the observations. Accordingly, since the appointment of Prof. Bigelow to the Weather Bureau he has been assigned to the study of this problem. Although it is too soon to have arrived at a full understanding of the question, it may be stated that such progress has been made as to render it quite certain that the two subjects are intimately associated, and that if their relations can be fully elucidated the solution will relate to those fundamental atmospheric considerations which it is most important to understand. Unless all signs fail, this field is a very promising one for securing contributions to our knowledge of the physical action of the atmosphere.

The method of analysis used by Prof. Bigelow differs from that which has been hitherto employed in this respect. Instead of making comparisons between the variations of the atmospheric elements, as displayed by the meteorological instruments, and some one of the magnetic components—that is, the declination, or the horizontal force, or the vertical force taken separately—a total deflecting force is computed from the variations of the magnetic elements, and this is compared with the meteorological changes. By this process Prof. Bigelow has been able also to disentangle several of the magnetic fields surrounding the earth, which we observe in the magnetic curves as an integrated effect.

Our thanks are due to the Navy Department, to Capt. F. C. McNair, superintendent of the U. S. Naval Observatory, and to Ensign J. A. Hoogewerff, U. S. Navy, for permission to use freely their meteorological and magnetic records, and for much practical coöperation, without which this work could not have been prosecuted in Washington.

SOIL PHYSICS.

In the conferences I held during my recent visit to several of the experiment stations, I carefully considered their wish, expressed in the last clause of the resolution adopted at the meeting of the Association of American Agricultural Colleges and Experiment Stations, held in Washington in August, to the effect that the sphere of the work of this Bureau "should be enlarged to include the physics, conditions, and changes of agricultural soils."

I find here an important field of work which they have opened up, having a direct bearing on our own work and offering an interpretation of our data, and showing their application to agriculture such as has not been attempted before. Our data are of conditions above the soil, and this stops short of the needs of agriculture, for the reason that the development of the plant is largely affected by the climatic conditions of heat and moisture under the surface of the ground. The rain which

falls does the plant little or no good until it enters the soil. It is upon the movement of the rainfall after it enters the soil that the development of the plant is largely dependent. A record of the amount of moisture in the soil would show a more direct practical bearing on agriculture than our rainfall tables have done in the past. This is what the stations wish in asking us to enlarge the scope of our work by including a study of what may be termed the meteorological conditions within the soil.

They have collected data showing the marked relation between the moisture in the soil and crop development. They think this explains the local distribution of crops; why the same crops often can not be grown with equal success upon the soils of adjoining fields. It is claimed that the relation of great soil types, or soil formations, to the distribution or development of plants is largely due to the difference in the movement of the rainfall after it enters these different soil formations.

This seems to me a perfectly legitimate field for us to occupy and that the work would be an important addition to the work at present done by the Weather Bureau. The scope of the work would include, first of all, a record of the amount of moisture in the soil in different localities. The observations could be taken at our regular observing stations, or by our voluntary observers and by coöperation with the experiment stations. The localities for these observations should be selected with care to include the principal soil formations, or soil types, best suited to the staple crops of the country. For example, it would be desirable to have a record of the actual amount of moisture in the upland cotton soils of the South, in the Sea Island cotton soils, in the several types of soils not adapted to the growth of cotton, in the soils of the great Blue Grass region, in the wheat, tobacco, and corn lands. A convenient method would have to be devised for the determination of the moisture in the soil in its natural position in the field and for the determination of the actual rate with which water can move through the soil in its natural position on the field, either when it is fully saturated or when it is only slightly moist.

It has been recently shown that the texture or structure of these soil formations or soil types differ, and that this largely determines the relation of these soils to the movement of the rainfall after it enters the ground; that it largely determines the ease with which water may be supplied to the plants. It is claimed that it is possible, from the mechanical analysis, as showing the structure or framework of the soils, to calculate the relative rate with which the rainfall will move after it enters the soil.

The area and distribution of the different soil formations are dependent upon the geology of a country. It should be possible for us to classify the soils of a country under a very few types according to the geological and botanical characteristics, and for us then to collect data to establish the relation of these soils to our ordinary meteorological conditions, and to work out a complete branch of the science in the meteorology of the soil. The practical benefit this would be to climatology and agriculture is perfectly obvious.

It is claimed that the deterioration of lands is largely due to a change in their structure, caused by a rearrangement of the soil grains, thus changing the relation of the soil to the circulation of water.

The determination of the actual rate with which water moves within the soil of any soil formation, under given conditions, will give a basis of comparison with the relative rate with which it should move, calcu-

lated from the structure or framework of the soil as shown by the mechanical analysis. Any difference between this observed rate and the calculated rate would indicate a change in the arrangement of the soil grains and suggest the direction in which the soil should be improved to better adapt it to a given crop.

It has been shown that the arrangement of the grains of soil may be varied at will with the ordinary fertilizing materials, and it is even claimed that a very important effect of fertilization is this physical action of the manures in changing the structure of the soil and its relation to the rate of movement of the soil moisture. If this be so, then our data would supply the basis for the improvement of lands. We would show the meteorological conditions of these soil formations, and particularly their relation to the movement of the rain after it falls and enters the ground. Our records would then show the actual conditions in regard to moisture and its available water supply under which the plant grows. If we thus establish the typical conditions of plant growth, any departure from these conditions in any local soil or great soil formation will indicate the changes which are desirable in the structure of the soil for a better development of the crop.

The simple record of moisture in the soil from time to time would undoubtedly have a great interest and wide practical application to agriculture. The work will also, as I have said, give a basis for the improvement of lands in suggesting changes in the relation of these soils to the meteorological conditions of a region.

The amount of water which a soil contains and the texture of the soil itself, as shown from the mechanical analysis, have an important effect upon the temperature of the soil and the amount of heat lost by radiation. It takes much more heat to raise a pound of water one degree than to raise a pound of soil one degree, so that under like conditions the temperature at midday of a soil saturated with water would be lower than if the soil were only slightly moist. The saturated soil would contain more material to be heated, and this added material is harder to heat than the soil itself.

There is another important effect of moisture upon the temperature of the soil in the rate with which evaporation takes place from the surface of the ground. On a hot, dry summer day, when evaporation is freely going on, more water will evaporate from a light sandy soil than from a clay land, and the temperature of the sandy soil will be considerably lower at midday than that of the clay land, whereas if the soils were both quite dry the sandy soil would have the highest temperature, because the sand is easier to heat than the clay. These effects of moisture on the temperature of the soil must have an important value in the development of plants.

A large amount of data on the temperature of soils has been accumulated by the experiment stations, but because of this influence of the moisture of the soil it has been difficult to give a true interpretation to the results or to show their relation to plant development. Soil-temperature observations could easily be taken on by the Bureau service at the observing stations and in coöperation with the experiment stations by the use of a few special instruments. The work should be made more general, with some broad, general plan, so that the results would give the relation of these great soil formations, or soil types, to heat. This would give a systematic study of the different soil formations, where any individual station can deal only with the soil of its immediate locality. For the reasons just given, the record of soil moisture should be an accompaniment to the soil temperature data, and

it would probably be possible, from the known texture of the soil, the size of the grains of soil, and the relation of the soil to the circulation of water, to determine also their relative relation to heat.

Another line in which the experiment stations have been working, and which might properly come within the scope of our own work, is in the study of the loss of heat from the soil or from objects freely exposed to radiation. The texture of the soil and its relation to both heat and moisture largely determine the relative rate with which the soil will lose heat by radiation, and so influence the occurrence of dew and frost. Both the solar and the terrestrial radiation thermometers should be included in this study of the meteorology of the soil, and they would probably give interesting results if the observing stations were selected in representative soil formations and in great crop areas.

This new field of investigation thus outlined appears so important and so full of promise of results of great practical value to agriculture, if the work is systematically arranged and carried out, that I think it would be well to establish a division in this Bureau devoted to the subject of meteorology in its relation to agricultural soils.

CLIMATIC LABORATORY.

The relations between the climates of the separate States and their local crops are supposed to be fully attended to by the respective agricultural colleges and the experimental stations, but there are many questions of a wider character that are proper to be discussed by this Bureau, as a part of the whole field and as a contribution to our general knowledge of the laws of the growth of plants. For instance, the question as to whether any given characteristic of a crop is due to the temperature of the air, or of the soil, the rainfall, the sun's heat, or the sun's light, or the constitution of the atmosphere, is one that belongs to this Bureau to determine. These are questions of the influence of meteorological climate, as distinguished from the influence of the soil, the fertilizers, variety of the seed, and the methods of culture. These latter questions are properly studied by the local experiment stations, but I know of no provision for studying the former by themselves. It is difficult to see how the question of climatic influence can be satisfactorily handled unless localities are provided in which crops may be grown under climatic conditions that are strictly under control as to temperature, moisture, atmosphere, and light. I therefore respectfully submit the following sketch of the conditions necessary to be fulfilled in a building adapted to this important study.

This building, which might properly be called a "climatic laboratory," should contain about ten rooms, each devoted to some one of our ten principal crops, and each room to furnish an available soil surface of about 1 square rod. Each room to be furnished with the means for completely regulating the temperature of the soil and that of the air, independently of each other; also, for controlling and altering, to a limited extent, the chemical nature of its atmosphere, its moisture, and its barometric pressure; also, a method of controlling the sunlight that enters by day and of substituting, by night, a powerful electric light in its stead. All of our present knowledge tends to demonstrate that the crop produced from any seed has its qualities and its time of ripening changed by temperature, moisture, and sunlight, and especially by the relative distribution of these during the period of growth; while the quantity of the crop—namely, the number and the size or weight—

depends on the nature and quantity of the fertilizer contained in the soil or water. The precise analysis and study of these complex relations has been attended with great difficulty in experimental work carried on in the open air or in the ordinary greenhouses. The absolute necessity of the climatic laboratory was strongly insisted on by A. de Candolle thirty years ago, and is still more evident from the data collected together in Prof. Abbe's report. The work to be conducted in this climatic laboratory is so important in its bearings on many questions that come before the Department of Agriculture, and on the general interests of the farmer, that it should give occasion for the formation of an independent division of the Department, if it is not thought proper to organize it under the Weather Bureau.

WEATHER CONDITIONS OF THE CROP OF 1891.

Prepared by H. H. C. DUNWOODY, *Acting Assistant Chief of the Weather Bureau.*

As editor of the Weather Crop Bulletin during the past four years, the writer has been associated with work having the most direct bearing upon agricultural interests and in line with that contemplated in the law transferring the Weather Bureau to the Department of Agriculture. Experience in this work has shown that the value of the information collected by this Bureau may be increased many fold by a wider distribution of the information collected by this office and an ability to utilize the same. No feature of the work of the Weather Bureau has been so highly commended by those interested in agriculture as the weather crop bulletins. These contain reliable statements of the weather conditions under which the crops of the present year were planted, cultivated, and harvested, and a summary of these bulletins has been prepared, covering the period from March 1 to October 1, in which the more important meteorological elements are presented in such form as to enable those who are interested in crop production to become thoroughly familiar with the conditions which have prevailed over the principal agricultural districts during the growing season, and this information, compared with the actual yield of the several crops, will serve as a record of comparison which, if continued from year to year, will enable those interested to form more reliable estimates of the influence of weather conditions on the more important crops. The conditions of rainfall and temperature are here represented in graphic form.

Plate V exhibits the seasonal conditions of rainfall from March 1 to September 25 throughout the United States, or during the growing period of the present year. From this chart it will be seen that more than the usual amount of rain occurred from Indian Territory and northern Texas northward over the west slope of the Missouri Valley, including the west half of South Dakota and the greater portions of North Dakota. This region of excessive rain extends to the Pacific coast, over Oregon and the greater portion of Washington. Within the limit of the shaded portion of the chart light lines indicating areas over which the rainfall ranged from 2 to 6 inches in excess of the usual amount, and the time of the occurrence of this rainfall, will be found in the weekly record of the stations, as given in the tabular statement. Small areas of excessive rainfall occurred over the eastern portion of the United States, as shown on the charts, while throughout the central valleys, including the greater portion of the cotton, corn, and wheat

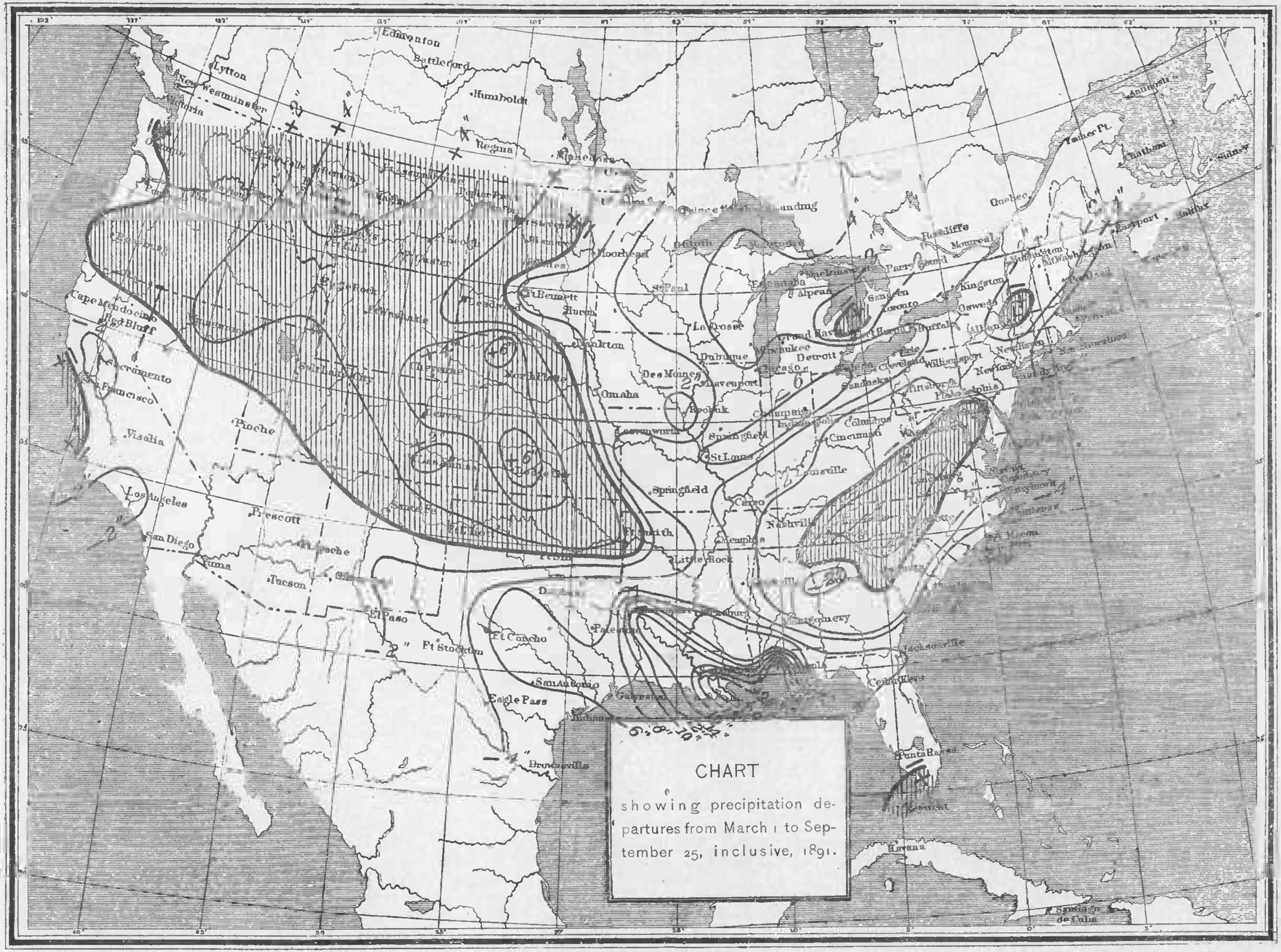
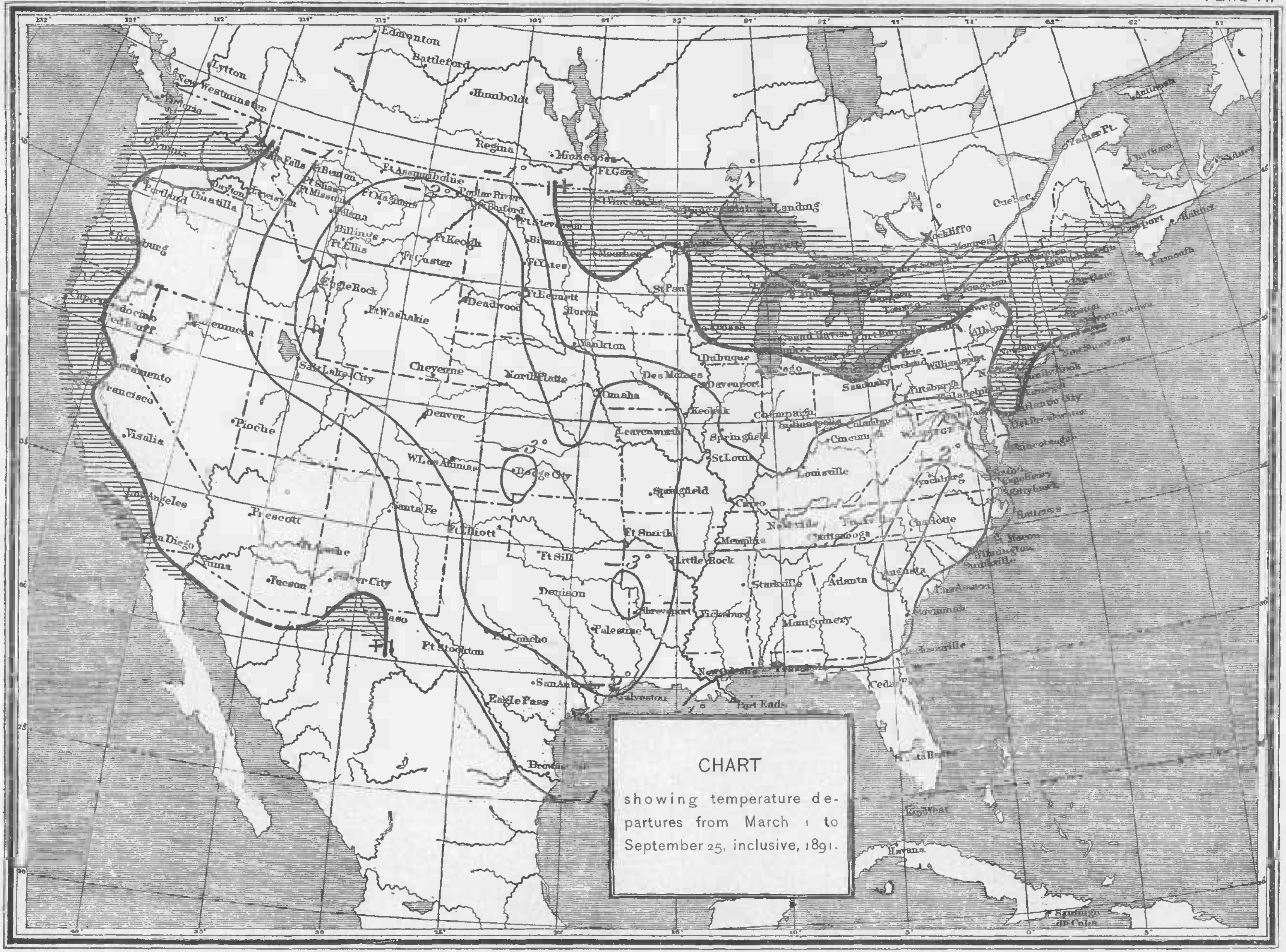


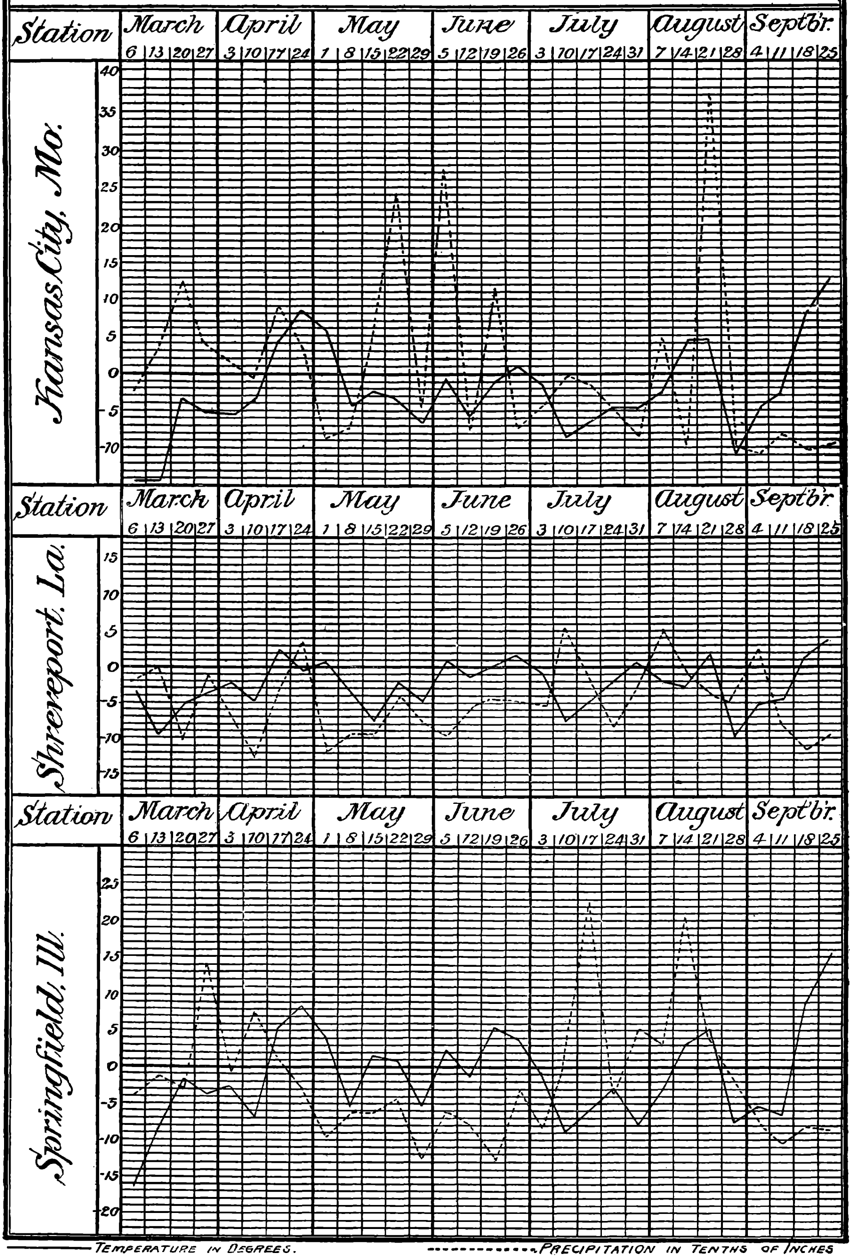
CHART showing precipitation departures from March 1 to September 25, inclusive, 1891.

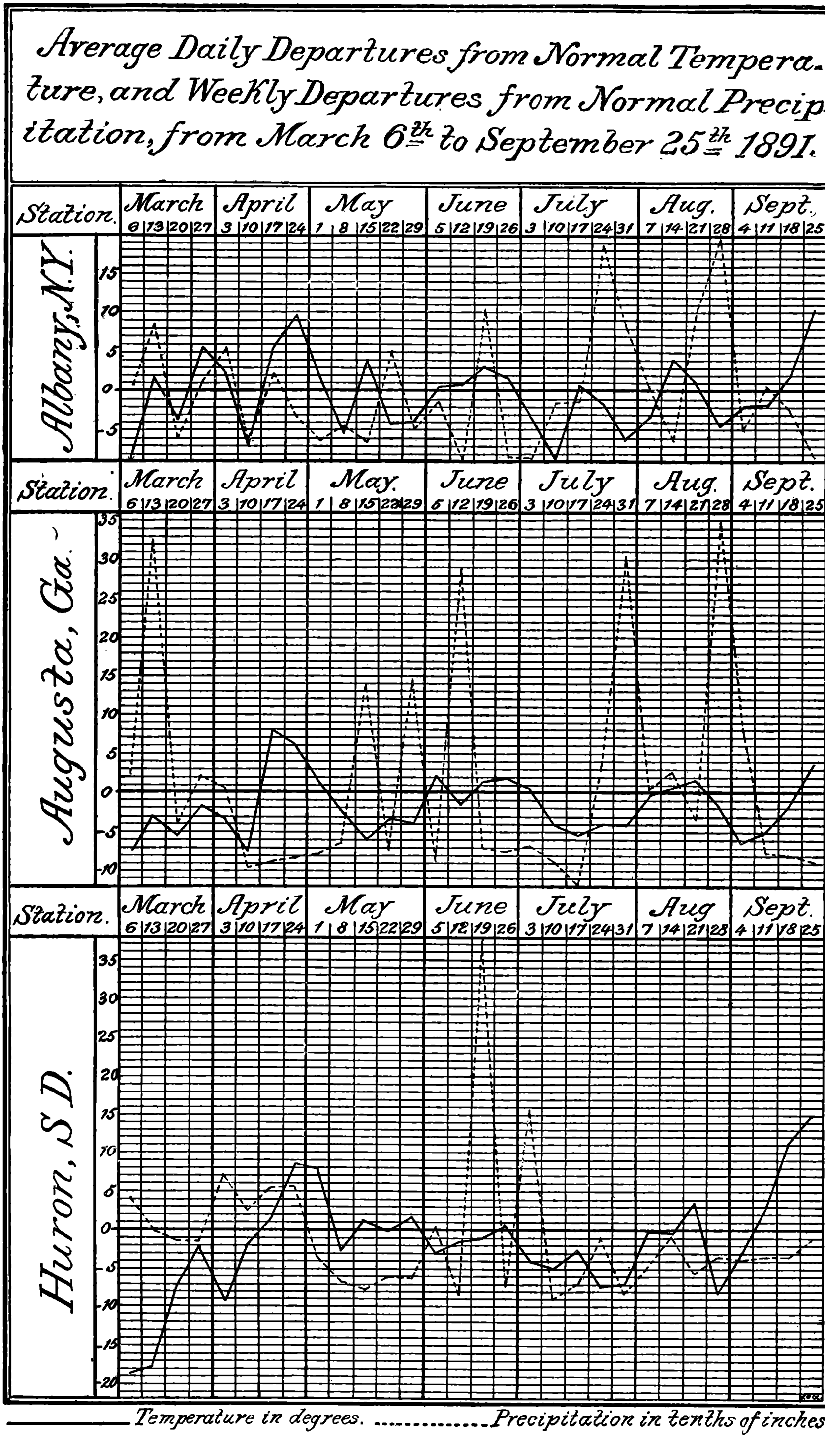


CHART

showing temperature departures from March 1 to September 25, inclusive, 1891.

Average Daily Departures from Normal Temperature, and Weekly Departures from Normal Precipitation, from March 6th to September 25th 1891.





Temperature in degrees. .... Precipitation in tenths of inches.

regions, the rainfall was less than usual. While the deficiency was slight and ranged only from 2 to 6 inches below the average of previous years in the corn and wheat States of the central valleys and in the northern portion of the cotton region, there was a marked deficiency in the lower Mississippi Valley along the Gulf coast, where the rainfall was 8 to 20 inches less than usual, the region of greatest drought including the sugar and rice regions of Louisiana. On the Pacific coast the rainfall was generally in excess in Oregon and Washington, while over the greater portion of California it was from 1 to 2 inches less than usual.

Plate VI exhibits the thermal conditions of the season as compared with the average of previous years, the shaded portions showing that in New England, over the lake region, and along the Pacific coast it was slightly warmer than usual, while throughout all principal agricultural districts the average daily temperature for the entire period was from 1 to 3 below the average.

Plates VII and VIII show the conditions of temperature and rainfall by weeks, for selected stations, viz, Kansas City, Shreveport, Springfield, Albany, Augusta, and Huron. These diagrams will serve as types to indicate the general weather conditions from week to week for the localities represented, and similar diagrams may be constructed for each of the stations named in the table. For example, the diagram for Springfield, Ill., the heavy horizontal line marked "0" is taken as the normal (or average) for both temperature and rainfall, and figures to the left indicate degrees when referring to temperature and tenths of inches when referring to rainfall. The full black line refers to temperature and the dotted line to rainfall. The full black line being below the zero line during the month of March and the first two weeks in April, indicates that this period was colder than usual for that locality, while during the same period the rainfall was in excess during the last week in March and the second week in April. From this date until the second week of July the rainfall was less than usual in central Illinois, while the temperature varied but slightly from the normal. After this followed the excessive rain of July and August, which proved so beneficial to the corn crop in the central Mississippi Valley. The weather had been cool up to that period, and the corn crop was retarded, but the excess in temperature which occurred in September, as is shown on the curves for Springfield and Kansas City, was the condition most favorable to the then retarded corn crop, as it hastened the ripening of the crop and saved it from frosts which occurred late in September. The tabular statements contain the departures from the normal for both temperature and rainfall for each week for the season of 1891. The first column in each table contains the conditions as compared with the normal from January 1 to the first week in March, the date of the issue of the first weekly bulletin; the remaining columns give the departures for each successive week. Table I refers to temperature and Table II to precipitation.

The tables thus present the seasonal conditions for each locality named in the table, and diagrams similar to those given in Plates VII and VIII may be readily constructed, which will present the data in more graphic form and facilitate comparisons.

In the study of the weather conditions for the year, the conditions which existed before the opening of the growing season and during the winter months should not be neglected. During the late winter and spring months the temperature was abnormally high over the principal agricultural districts east of the Rocky Mountains, especially in the

Northwest, and the ground was well filled with moisture at the opening of the growing season.

With a view of securing a more detailed statement which would show the march of the season in the several States, I have secured from the directors of the several State weather services a general statement of the weather crop conditions in their respective States from the opening of the growing season until the end of September, 1891. As these statements contain much valuable information, which may be utilized by farmers interested in the study of the weather and the effects of the same upon crops, they are herewith submitted. These reports from the cotton region States, having been prepared before the close of the growing season in that section, necessarily do not give the condition of the cotton crop at maturity, but the estimates as given will doubtless closely approximate the actual state of the crop.

TABLE I.—*Temperature departures for the season of 1891 from the normal of many years.*

Stations.	From Jan. 1 to Mar. 6 inclusive.	For the weeks ending—											
		March			April				May				
		13.	20.	27.	3.	10.	17.	24	1.	8.	15.	22.	29.
New England States:													
Eastport, Me	+86	+50	−20	+16	+10	+8	+25	+1	−5	+8	+10	−7	+5
Portland, Me	+104	+43	−19	+12	+6	−9	+32	+53	−14	−25	−21	−33	−37
Boston, Mass	+236	+40	−17	+11	−2	−26	+38	+73	+6	−14	+10	+11	−18
Middle Atlantic States:													
Albany, N. Y	+25	+11	−25	+39	+16	−47	+37	+67	+11	−38	+28	−30	−28
New York City, N. Y	+217	+43	−6	+21	0	−39	+49	+80	+37	−22	+34	−4	−15
Philadelphia, Pa	+184	+24	−29	+10	−15	−43	+56	+82	+32	−33	+29	−1	−38
Washington City, D. C	+233	+8	−20	+1	−26	−60	+49	+82	+27	−29	+2	−2	−53
Lynchburg, Va	+46	−18	−31	−10	−30	−69	+58	+75	+25	−29	−19	−13	−49
Norfolk, Va	+167	+20	−30	−18	−23	−56	+63	+54	+18	−24	−10	−5	−25
South Atlantic States:													
Charlotte, N. C	+75	−20	−33	−15	−21	−71	+58	+50	+19	−16	−29	−14	−31
Wilmington, N. C	+117	+21	−23	+8	−12	−53	+55	+31	0	−25	−17	−26	−11
Charleston, S. C	+141	+12	−32	+2	−15	−43	+38	+30	−4	−10	−25	−22	−20
Augusta, Ga	+63	−20	−37	−12	−23	−52	+55	+42	+10	−18	−42	−24	−28
Savannah, Ga	+80	0	−39	−4	−26	−59	+31	+14	−5	−12	−25	−32	−27
Jacksonville, Fla	+148	+25	−32	−1	−17	−69	+26	+9	−7	−14	−21	−17	−19
Gulf States:													
Atlanta, Ga	+13	−46	−39	−4	−33	−57	+46	+42	+28	−7	−21	−13	−7
Mobile, Ala	+65	−26	−30	+14	−9	−66	+12	+14	−1	−21	−25	−8	−3
Montgomery, Ala	+91	−41	−29	+18	−18	−62	+39	+34	+9	−12	−21	−13	−12
Vicksburg, Miss	+136	−51	−45	+2	−10	−49	+27	+23	+3	−17	−38	−3	−6
New Orleans, La	+122	−45	−41	−4	−9	−57	+12	+6	+6	−16	−28	−7	+9
Shreveport, La	+64	−67	−37	−27	−17	−36	+18	−3	+3	−25	−52	−15	−32
Fort Smith, Ark	+54	−84	−31	−15	−31	−30	+24	+30	+15	−22	−40	+5	−32
Little Rock, Ark	−4	−80	−44	−12	−23	−26	+28	+38	+8	−30	−33	+1	−23
Palestine, Tex	+94	−104	−52	−42	−12	−24	+23	−4	+9	−8	−50	+7	−16
Galveston, Tex	+76	−52	−40	−22	−11	−28	−1	−4	+9	−6	−30	0	−20
San Antonio, Tex	−12	−78	−57	−19	−12	−13	+12	−32	−11	−14	−47	−6	−32
Ohio Valley and Tennessee:													
Memphis, Tenn	+147	−55	−31	−5	−17	−26	+43	+51	+11	−31	−26	+15	−18
Nashville, Tenn	+159	−24	−11	0	−41	−43	+45	+52	+12	−41	−19	−2	−18
Chattanooga, Tenn	+101	−28	−17	0	−30	−56	+52	+52	+25	−8	−8	−14	−1
Knoxville, Tenn	+107	−15	−17	+4	−28	−63	+53	+54	+17	−26	−28	−13	−8
Louisville, Ky	+201	−18	−24	−6	−31	−45	+60	+71	+22	−39	−12	+6	−36
Indianapolis, Ind	+204	−16	−24	−7	−13	−44	+56	+83	+16	−41	−3	0	−59
Cincinnati, Ohio	+136	−20	−33	−9	−19	−53	+53	+76	+15	−52	−21	−10	−64
Columbus, Ohio	+196	−7	−31	+2	+4	−57	+46	+67	+12	−46	−8	−17	−65
Pittsburg, Pa	+237	+28	−16	+5	+4	−54	+41	+83	+9	−50	−1	−13	−48
Lake Region:													
Oswego, N. Y	+113	+42	−34	+19	+27	−40	+34	+40	+14	−37	+12	−13	−51
Buffalo, N. Y	+252	+43	−18	+25	+43	−27	+41	+42	0	−48	+6	−11	−22
Cleveland, Ohio	+292	+23	−10	+5	+18	−36	+43	+64	+37	−39	+7	−14	−45
Detroit, Mich	+134	0	−37	−4	+11	−46	+27	+56	+34	−32	+16	−15	−36
Alpena, Mich	+313	+58	−25	+32	+40	−29	+22	+56	+70	−21	+32	−12	−22
Grand Haven, Mich	+187	+1	−22	+9	+7	−44	+19	+45	+14	−47	+5	−16	−25
Milwaukee, Wis	+325	−30	−6	+12	+16	−46	+16	+40	+56	−13	+28	−12	−52
Chicago, Ill	+221	−49	−23	−3	+7	−67	+26	+42	+47	−33	+28	−25	−70
Duluth, Minn	+298	−27	−57	−12	+3	−16	+14	+23	+44	+3	+39	−20	−7
Upper Mississippi Valley:													
St. Paul, Minn	+176	−63	−55	+15	−15	−34	+21	+44	+56	−24	+31	+10	−13
La Crosse, Wis	+259	−46	−33	−1	−9	−50	+19	+50	+61	−16	+41	+6	−34

TABLE I.—*Temperature departures for the season of 1891 from the normal of many years*—Continued.

Stations.	From Jan. 1 to Mar. 6 inclusive.	For the weeks ending— March			April				May				
		13.	20.	27.	3.	10.	17.	24.	1.	8.	15.	22.	29.
Upper Mississippi Valley—Continued.													
Davenport, Iowa	+256	− 70	−35	−17	− 13	−51	+32	+63	+47	−34	+20	−14	−40
Des Moines, Iowa	+302	− 67	−29	−16	− 39	−39	+25	+55	+43	−41	+ 3	−29	−39
Springfield, Ill	+126	− 59	−13	−32	− 19	−48	+37	+58	+27	−38	+10	+ 6	−36
Cairo, Ill	+167	− 47	−10	− 8	− 24	−32	+41	+61	+16	−41	−16	+10	−40
St. Louis, Mo	+208	− 53	− 7	−24	− 25	−37	+37	+62	+27	−43	+ 2	+ 6	−45
Missouri Valley:													
Springfield, Mo	+103	− 76	− 5	−21	− 35	−38	+25	+47	+17	−39	−43	−23	−50
Kansas City, Mo	+114	−100	−26	−42	− 45	−26	+25	+59	+38	−30	−15	−23	−47
Concordia, Kans	+206	− 82	+15	−34	− 57	− 6	+48	+53	+52	− 1	0	−32	−34
Omaha, Nebr	+172	− 97	−12	−35	− 46	−28	+24	+59	+58	−31	+ 5	−30	−29
Valentine, Nebr	− 27	−133	−19	−23	− 72	−33	+ 8	+48	+56	−15	− 6	− 9	+ 7
Huron, S. Dak	+314	−123	−50	−15	− 38	−15	+ 9	+59	+52	−13	+ 8	− 1	+11
Extreme Northwest:													
Moorhead, Minn	+318	−102	−45	− 9	+ 15	+32	+28	+88	+79	− 2	+ 7	+12	+23
Bismarck, N. Dak	+434	−116	−18	−22	− 12	+28	+13	+71	+62	0	0	+ 2	+13
Fort Buford, N. Dak	+266	−107	+16	+19	− 1	+40	+34	+59	+30	−11	− 5	+10	+20
Rocky Mountain Slope:													
Fort Assinaboine Mont	+122	−104	+13	+ 6	− 38	+45	+23	+45	+ 1	− 8	+ 9	+ 3	+19
Cheyenne, Wyo	−116	− 98	+ 6	−42	− 77	− 1	+ 1	+24	+40	+55	− 4	−47	−10
North Platte, Nebr	− 4	−116	+ 8	−46	− 79	−29	+14	+41	+57	+15	+12	−27	− 5
Denver, Colo	−270	− 86	+ 6	−64	−108	−23	+ 7	+10	+65	+68	− 6	−57	−20
Dodge City, Kans	+ 84	−112	− 1	−79	− 74	−13	+20	+36	+39	+16	−29	−25	−32
Pacific Coast:													
Olympia, Wash	− 18	− 9	+21	−10	− 76	+ 3	+23	−11	− 3	−10	+17	+15	+34
Portland, Oregon	− 21	− 23	+ 1	−20	− 37	− 4	+14	−16	−11	− 1	+ 6	+ 6	+ 7
Roseburg, Oregon	− 70	0	+18	−12	− 32	−15	− 1	+ 8	+13	+12	−10	+ 6	+ 2
Red Bluff, Cal	− 39	− 4	+20	−10	− 12	−48	−47	+ 1	+14	− 6	−17	+28	−30
Sacramento, Cal	− 23	+ 6	+19	0	− 11	−17	−39	− 4	+21	− 9	−28	+16	−34
San Francisco, Cal	+ 56	+ 4	+16	− 8	− 6	−35	−28	−22	+13	− 1	−31	−16	−24
Los Angeles, Cal	+ 38	+ 6	+11	− 1	+ 2	− 2	−34	−11	+12	− 8	−17	−24	−16
San Diego, Cal	− 13	− 10	+ 9	− 3	− 4	− 6	−23	0	− 2	− 2	−10	− 7	−10

Stations.	For the weeks ending— June				July				
	5.	12.	19.	26.	3.	10.	17.	24.	31.
New England States:									
Eastport, Me	−11	+ 7	+24	− 7	−23	−20	+ 1	−31	−27
Portland, Me	−24	+13	+25	−24	−33	−32	− 4	−25	−29
Boston, Mass	−14	+35	+17	−30	−54	−47	+12	− 8	−27
Middle Atlantic States:									
Albany, N. Y	+ 3	+ 4	+22	+11	−26	−61	+ 4	−11	−43
New York City, N. Y	+19	− 2	+18	+22	−39	−38	− 3	− 4	−27
Philadelphia, Pa	+14	−23	+11	+18	−30	−49	− 8	−13	−35
Washington City, D. C	+ 6	−35	+21	+17	−28	−62	−49	+22	−20
Lynchburg, Va	−10	−47	+36	+12	−28	−76	−38	− 7	−28
Norfolk, Va	− 8	−25	+36	+30	−10	−37	−44	−27	−17
South Atlantic States:									
Charlotte, N. C	+10	−32	+16	+13	− 6	−52	−55	−18	−27
Wilmington, N. C	+ 7	−28	+16	+20	+ 8	−28	−42	−22	−21
Charleston, S. C	+ 9	− 5	+ 8	+17	+11	−12	−39	−23	− 4
Augusta, Ga	+15	−11	+10	+13	+ 3	−28	−37	−28	−29
Savannah, Ga	+22	− 4	+ 1	+ 9	+10	−26	−50	−27	− 7
Jacksonville, Fla	+25	− 5	− 4	+ 2	+15	− 9	−25	−18	+ 9
Gulf States:									
Atlanta, Ga	+37	−18	+18	+18	+14	−28	−44	−18	−24
Mobile, Ala	+ 3	− 4	− 6	+21	+ 6	−23	−15	− 6	− 3
Montgomery, Ala	+27	− 7	+ 3	+18	+ 8	−32	−25	−12	− 7
Vicksburg, Miss	+23	− 3	+ 7	+28	+11	−38	−21	−12	− 8
New Orleans, La	+ 6	− 5	−17	+14	+10	−37	− 5	0	− 2
Shreveport, La	+ 6	− 8	0	+12	− 7	−53	−32	−14	+ 2
Fort Smith, Ark	+24	− 3	+17	+ 6	−12	−47	−40	−19	−44
Little Rock, Ark	+33	− 5	− 7	+16	+ 1	−41	−41	−19	−43
Palestine, Tex	+19	− 4	−17	+13	−10	−49	−17	−12	+12
Galveston, Tex	......	− 8	0	− 1	− 8	−37	−14	−11	− 2
San Antonio, Tex	+13	− 3	+ 5	+18	− 7	− 1	− 6	+ 5	+27
Ohio Valley and Tennessee:									
Memphis, Tenn	+41	− 8	− 2	+18	+10	−46	−35	−12	−36
Nashville, Tenn	+32	+ 6	+16	+19	+ 3	−51	−26	−24	−27
Chattanooga, Tenn	+39	+ 5	+16	+19	+ 3	−35	−28	−10	−21
Knoxville, Tenn	+30	+10	+23	+15	− 5	−42	−24	− 5	−20
Louisville, Ky	+16	+16	+34	+21	− 2	−65	−25	−18	−24

TABLE I.—*Temperature departures for the season of 1891 from the normal of many years*—Continued.

Stations.	For the weeks ending—								
	June				July				
	5.	12.	19.	26.	3.	10.	17.	24.	31.
Ohio Valley and Tennessee—Continued.									
Indianapolis, Ind	+17	−13	+38	+26	− 2	−53	−32	− 8	−33
Cincinnati, Ohio	+ 2	−12	+30	+17	−11	−65	−39	−29	−43
Columbus, Ohio	+ 8	−10	+49	+28	−10	−69	−42	−23	−38
Pittsburg, Pa	+ 3	−14	+49	+17	−17	−70	−20	−13	−44
Lake Region:									
Oswego, N. Y	−23	+ 6	+27	+10	−13	−73	− 5	−21	−47
Buffalo, N. Y	− 4	+19	+23	+32	− 6	−60	−12	−11	−40
Cleveland, Ohio	+ 5	+ 2	+23	+26	− 2	−47	− 9	− 7	−37
Detroit, Mich	+ 6	+ 3	+27	+26	−17	−62	− 9	−22	−44
Alpena, Mich	−20	0	+27	+37	−10	−38	+21	−34	−47
Grand Haven, Mich	+ 3	+12	+42	−38	− 4	−60	−30	−30	−44
Milwaukee, Wis	−12	+ 2	+ 9	+17	−14	−58	+ 5	−21	−46
Chicago, Ill	−23	− 9	+12	+10	−28	−64	− 8	−14	−55
Duluth, Minn	−77	−17	−20	+ 1	−42	−30	−31	−58	−24
Upper Mississippi Valley:									
St. Paul, Minn	−24	−18	+ 8	+15	−41	−63	−27	−39	−42
La Crosse, Wis	+ 6	− 9	+21	+24	−35	−70	−26	−39	−44
Davenport, Iowa	0	−28	+30	+33	−20	−60	−42	−29	−37
Des Moines, Iowa	− 2	−43	+10	+14	−26	−61	−36	−40	−40
Springfield, Ill	+17	−12	+35	+26	− 4	−63	−40	−22	−56
Cairo, Ill	+39	+11	+ 6	+16	+ 7	−44	−34	−14	−31
St. Louis, Mo	+23	− 9	+12	+17	− 4	−44	−36	−19	−35
Missouri Valley:									
Springfield, Mo	+22	− 4	−14	+ 1	− 7	−65	−55	−26	−28
Kansas City, Mo	− 4	−42	− 9	+ 5	− 9	−61	−49	−35	−34
Concordia, Kans	+12	−46	−18	+ 6	− 2	−55	−35	−14	−30
Omaha, Nebr	− 8	−49	+ 2	+12	−10	−64	−42	−38	−31
Valentine, Nebr	−14	−17	−36	− 4	−18	−48	−55	−45	−23
Huron, S. Dak	−21	−11	− 8	+ 4	−28	−34	−18	−51	−48
Extreme Northwest:									
Moorhead, Minn	−43	− 7	+ 7	+18	−34	−24	−14	−56	−28
Bismarck, N. Dak	−66	−16	−32	0	−36	−26	−32	−52	−51
Fort Buford, N. Dak	−76	−35	−48	−43	−43	−21	−44	−43	−55
Rocky Mountain Slope:									
Fort Assinaboine, Mont	−56	−36	−26	−39	− 2	+11	−31	−24	− 9
Cheyenne, Wyo	−24	+ 2	−34	−14	−25	−31	−46	− 6	−23
North Platte, Nebr	−13	−26	−42	− 3	−18	−54	−42	−17	−19
Denver, Colo	−36	+ 7	−37	− 8	−25	−39	−41	− 9	−28
Dodge City, Kans	+14	−38	−47	+ 1	−12	−47	−33	−28	−36
Pacific Coast:									
Olympia, Wash	− 6	−25	−11	−20	+18	−29	−13	+21	+ 3
Portland, Oregon	−22	−40	−20	−28	+25	−24	+23	+25	− 6
Roseburg, Oregon	−24	−38	− 8	−27	+31	−34	+ 9	+37	+ 5
Red Bluff, Cal	−47	−24	−32	−35	+74	−51	+12	+40	+32
Sacramento, Cal	−39	−13	−23	− 6	+96	−13	+13	+47	+13
San Francisco, Cal	−18	−20	− 6	+ 1	+62	......	− 8	+ 5	−20
Los Angeles, Cal	−26	−10	−17	− 9	+15	− 7	−12	+33	+33
San Diego, Cal	−12	− 7	− 4	−14	− 2	− 8	− 9	+22	+25

Stations.	For the weeks ending—								
	August				September				Oct
	7.	14.	21.	28.	4.	11.	18.	25.	2.
New England States:									
Eastport, Me	− 5	+ 8	− 1	+ 3	+ 5	+17	+ 9	+ 30	+45
Portland, Me	− 6	+33	+ 1	+ 9	− 3	− 2	+38	+ 66	+49
Boston, Mass	−20	+37	+ 9	+39	−17	− 8	+34	+ 55	+56
Middle Atlantic States:									
Albany, N. Y	−23	+29	+ 7	+33	−14	−13	+14	+ 72	+54
New York City, N. Y	−16	+45	+13	+38	−18	− 9	+16	+ 61	+45
Philadelphia, Pa	−19	+40	0	+33	−23	−18	+21	+ 72	+56
Washington City, D. C	− 8	+37	+ 8	+19	−18	−25	+12	+ 55	+42
Lynchburg, Va	−18	+25	+ 8	0	−29	−25	+ 8	+ 66	+32
Norfolk, Va	− 2	+23	+14	+29	−20	− 7	+ 7	+ 30	+39
South Atlantic States:									
Charlotte, N. C	− 9	+20	+25	− 2	−40	−28	+ 6	+ 51	+37
Wilmington, N. C	+ 1	+15	+21	+20	−26	− 9	+ 9	+ 16	+27
Charleston, S. C	+15	+13	+26	+13	−17	−10	+ 6	+ 22	+18
Augusta, Ga	− 4	+ 5	+11	−11	−44	−35	−11	+ 26	+24
Savannah, Ga	+12	+ 2	+17	+ 1	−19	−10	+ 4	+ 13	+13
Jacksonville, Fla	+14	− 3	+14	+10	−14	− 5	+ 1	+ 3	+ 6

TABLE I.—*Temperature departures for the season of 1891 from the normal of many years*—Continued.

Stations.	For the weeks ending—								
	August				September				Oct
	7.	14.	21.	28.	4.	11.	18.	25.	2.
Gulf States:									
Atlanta, Ga	−7	+22	+38	−14	−23	−39	−4	+52	+38
Mobile, Ala	−4	+3	+18	−24	−13	−48	0	+26	+33
Montgomery, Ala	−9	+19	+31	−5	−5	−34	0	+32	+30
Vicksburg, Miss	−12	−6	+18	−58	−38	−42	+14	+40	+44
New Orleans, La	−1	+3	+16	−24	−12	−33	−1	+12	+26
Shreveport, La	−14	−21	+12	−67	−37	−45	+9	+26	+26
Fort Smith, Ark	−26	−3	+36	−69	−28	−32	+24	+42	+45
Little Rock, Ark	−22	−10	+27	−73	−44	−36	+18	+52	+45
Palestine, Tex	−13	−15	+15	−55	−24	−37	+14	+26	+43
Galveston, Tex	−8	−3	+14	−33	−5	−20	+6	−6	+24
San Antonio, Tex	+7	+15	+23	−22	−1	−2	+23	+17	+38
Ohio Valley and Tennessee:									
Memphis, Tenn	−23	+10	+36	−61	−43	−34	+25	+71	+53
Nashville, Tenn	−18	+22	+34	−51	−51	−42	+15	+63	+60
Chattanooga, Tenn	−16	+15	+36	−17	−26	−37	−8	+48	+52
Knoxville, Tenn	−4	+17	+19	−15	−23	−41	−7	+51	+58
Louisville, Ky	−15	+27	+17	−55	−42	−38	+26	+73	+48
Indianapolis, Ind	−16	+40	+29	−50	−29	−32	+58	+107	+72
Cincinnati, Ohio	−19	+22	+12	−61	−43	−48	+18	+71	+49
Columbus, Ohio	−9	+36	+19	−43	−23	−35	+25	+87	+63
Pittsburg, Pa	−23	+33	+17	−17	−26	−36	+18	+73	+58
Lake Region:									
Oswego, N. Y	−23	+22	+9	+8	−6	−18	+16	+61	+61
Buffalo, N. Y	−6	+24	+30	−19	−10	−20	+27	+71	+54
Cleveland, Ohio	−11	+46	+31	−21	−15	−20	+46	+71	+61
Detroit, Mich	0	+40	+35	−33	−24	−26	+51	+98	+63
Alpena, Mich	−8	+32	+32	−17	−16	−27	+48	+106	+75
Grand Haven, Mich	−4	+31	+39	−32	−21	−30	+44	+98	+66
Milwaukee, Wis	0	+45	+21	−50	−46	−34	+78	+121	+59
Chicago, Ill	−11	+22	+18	−62	−52	−34	+66	+110	+70
Duluth, Minn	−17	+13	+16	−43	−11	+25	+33	+105	+56
Upper Mississippi Valley:									
St. Paul, Minn	+11	+16	+24	−67	−42	−4	+61	+125	+54
La Crosse, Wis	+6	+26	+29	−56	−44	−9	+74	+134	+69
Davenport, Iowa	−10	+19	+35	−62	−37	−27	+64	+109	+74
Des Moines, Iowa	−8	+11	+25	−74	−42	−21	+67	+102	+53
Springfield, Ill	−24	+22	+36	−54	−39	−30	+61	+108	+63
Cairo, Ill	−20	+10	+24	−68	−34	−29	+35	+79	+60
St. Louis, Mo	−19	+27	+21	−58	−34	−25	+52	+99	+66
Missouri Valley:									
Springfield, Mo	−28	+16	+29	−73	−36	−17	+44	+78	+62
Kansas City, Mo	−19	+30	+30	−75	−34	−19	+53	+87	+65
Concordia, Kans	+1	+37	+40	−56	−22	−14	+51	+78	+33
Omaha, Nebr	+5	+33	+28	−64	−28	−9	+75	+93	+43
Valentine, Nebr	+20	+8	+20	−57	−3	+7	+76	+50	+15
Huron, S. Dak	−1	−2	+25	−58	−21	+16	+78	+97	+48
Extreme Northwest:									
Moorhead, Minn	+46	−1	+19	−48	−14	−3	+58	+116	+37
Bismarck, N. Dak	+10	−35	+4	−46	+3	+18	+55	+64	+9
Fort Buford, N. Dak	+3	−60	−8	−46	+1	+27	+35	+40	−35
Rocky Mountain Slope:									
Fort Assinaboine, Mont	−31	−46	−8	−13	+27	+38	+35	+26	−33
Cheyenne, Wyo	+15	+19	+7	−34	+2	+18	+46	+2	−16
North Platte, Nebr	+4	+8	+8	−55	−14	−3	+52	+49	+28
Denver, Colo	−6	+16	0	−31	−5	+15	+50	+8	+9
Dodge City, Kans	−11	+8	+26	−57	−33	−22	+46	+33	+15
Pacific Coast:									
Olympia, Wash	−21	+27	+17	+45	+3	+7	+14	−5	−25
Portland, Oregon	−28	+29	+23	+78	+36	+13	−8	−16	−28
Roseburg, Oregon	−29	+7	+22	+85	+41	+27	+13	+1	−18
Red Bluff, Cal	−21	−7	+2	+64	+55	+16	−52	−4	−14
Sacramento, Cal	−11	+12	+12	+47	+27	+15	−35	−9	+2
San Francisco, Cal	−4	−7	+24	+24	+3	−14	+2	+17	......
Los Angeles, Cal	−14	+14	+28	+34	+23	+66	−13	+4	+18
San Diego, Cal	−1	+11	+35	+27	+33	+61	−4	−4	−4

TABLE II.—*Precipitation departures for the season of 1891 from the normal of many years.*

Stations.	From Jan. 1 to Mar. 6, inclusive.	For the weeks ending— March 13.	March 20.	March 27.	April 3.	April 10.	April 17.	April 24.
New England States:								
Eastport, Me	+ .19	+ .12	— .60	— .98	— .62	— .75	— .21	— .41
Portland, Me	+4.75	+2.85	— .67	+ .43	— .11	— .70	— .02	— .21
Boston, Mass	+ .70	+ .03	— .97	+ .61	— .04	— .91	— .19	— .72
Middle Atlantic States:								
Albany, N. Y	+5.05	+ .86	— .60	+ .12	+ .53	— .62	+ .22	— .31
New York City, N. Y	+2.55	+1.44	— .89	+ .59	+ .35	— .82	— .15	— .25
Philadelphia, Pa	+1.57	+1.09	— .11	+ .49	+ .30	— .69	+ .91	— .51
Washington City, D. C	+3.92	+1.24	— .51	+2.58	+1.59	— .74	+1.07	— .13
Lynchburg, Va	+4.92	+1.43	— .31	+ .91	+1.13	— .72	+1.10	— .15
Norfolk, Va	+ .94	+ .17	— .53	+2.85	+ .41	— .68	+ .08	— .81
South Atlantic States:								
Charlotte, N. C	+1.58	+4.22	— .02	+1.65	+ .30	+ .06	— .41	— .09
Wilmington, N. C	—1.17	+1.15	— .98	+ .37	+ .52	— .80	— .38	— .40
Charleston, S. C	—4.92	— .03	+ .87	+1.67	+ .12	— .88	.00	— .89
Augusta, Ga	— .89	+3.24	— .40	+ .22	+ .06	— .95	— .89	— .82
Savannah, Ga	—3.95	+ .92	+1.49	— .03	+ .95	— .98	— .65	+ .04
Jacksonville, Fla	—5.80	+ .28	+ .91	+ .57	— .39	— .70	— .70	— .10
Gulf States:								
Atlanta, Ga	+4.35	+3.74	—1.00	+ .07	+1.15	— .86	— .51	— .56
Mobile, Ala	+ .46	+1.08	— .76	+ .56	— .94	— .32	—1.24	— .63
Montgomery, Ala	+ .45	+4.50	—1.39	+1.03	+ .41	—1.00	—1.35	— .41
Vicksburg, Miss	+3.61	+5.60	—1.47	—1.15	— .60	— .88	—1.26	+ .52
New Orleans, La	+ .51	— .60	— .44	— .29	—1.26	—1.18	—1.26	—1.08
Shreveport, La	—1.78	— .02	—1.03	— .09	— .72	—1.30	— .35	+ .36
Fort Smith, Ark	—1.57	+ .47	— .02	— .15	+ .97	— .83	— .28	+ .76
Little Rock, Ark	— .03	+1.58	—1.03	+ .18	— .02	— .95	+1.22	— .39
Palestine, Tex	+4.21	— .22	— .84	+ .22	— .56	+ .14	+2.29	+3.55
Galveston, Tex	+3.70	— .19	+ .48	— .02	— .68	— .63	— .53	+ .78
San Antonio, Tex	+3.05	— .42	— .03	+ .05	— .72	— .68	+ .51	+2.35
Ohio Valley and Tennessee:								
Memphis, Tenn	— .04	+2.20	—1.25	— .18	+ .39	— .88	+ .23	— .59
Nashville, Tenn	+3.80	+3.92	— .96	+ .44	+ .03	— .56	— .93	+ .04
Chattanooga, Tenn	+4.52	+2.52	—1.39	+ .34	+ .40	— .20	— .82	+ .15
Knoxville, Tenn	+4.52	+1.85	—1.05	+ .41	— .13	—1.06	—1.15	+ .30
Louisville, Ky	+ .40	+ .47	— .10	+1.28	+ .94	— .41	— .85	— .02
Indianapolis, Ind	+ .99	— .17	— .16	+1.47	+1.28	+ .26	— .50	— .54
Cincinnati, Ohio	— .36	— .02	— .15	+1.17	+ .64	— .18	— .37	— .41
Columbus, Ohio	+1.33	— .10	+ .48	+ .27	+ .64	— .02	— .24	+ .19
Pittsburg, Pa	+2.33	+ .59	— .08	— .28	+ .14	— .30	— .15	— .48
Lake Region:								
Oswego, N. Y	— .18	+1.36	+ .19	+ .43	— .18	— .28	+ .77	— .45
Buffalo, N. Y	+ .59	+ .12	— .12	— .34	— .08	— .07	.00	— .54
Cleveland, Ohio	+1.57	+ .23	— .04	— .43	+ .56	— .16	— .20	— .37
Detroit, Mich	— .63	+ .04	— .19	— .47	+ .64	— .09	+1.45	— .25
Alpena, Mich	+ .67	+ .13	+ .29	— .33	+ .64	— .35	+ .05	— .14
Grand Haven, Mich	+ .21	— .02	— .37	— .41	+ .59	— .07	+ .11	.00
Milwaukee, Wis	— .06	— .10	— .37	+ .24	+ .41	+1.79	— .20	— .33
Chicago, Ill	— .47	— .22	— .48	— .09	.00	+ .95	+ .25	— .13
Duluth, Minn	+ .79	+ .92	— .11	+ .21	+ .32	— .12	— .50	+ .05
Upper Mississippi Valley:								
St. Paul, Minn	+ .24	+ .02	— .28	— .26	— .03	+ .53	— .46	— .04
La Crosse, Wis	+1.44	+ .86	— .35	— .16	+ .29	+ .24	— .06	+ .49
Davenport, Iowa	— .01	— .11	— .40	+ .08	— .31	+ .37	+ .17	+ .87
Des Moines, Iowa	+ .38	+ .30	+ .19	+ .38	— .31	+ .24	— .03	+ .16
Springfield, Ill	—2.74	— .18	— .30	+1.41	— .07	+ .77	+ .16	— .22
Cairo, Ill	— .27	+1.06	— .49	+ .24	+ .28	— .52	— .40	— .61
St. Louis, Mo	—1.28	— .26	.00	.00	— .42	— .36	+ .16	— .10
Missouri Valley:								
Springfield, Mo	— .96	— .50	— .37	— .42	— .60	+ .21	+ .64	+ .48
Kansas City, Mo	+1.13	+ .32	+1.23	+ .40	+ .13	— .03	+ .91	+ .31
Concordia, Kans	+ .91	+ .34	.00	+1.78	+ .11	— .70	+ .80	— .09
Omaha, Nebr	+1.76	+ .61	+ .27	.00	— .42	— .68	+1.24	+ .10
Valentine, Nebr	+2.27	— .19	— .20	— .08	+ .75	— .27	+ .03	+1.57
Huron, S. Dak	+ .89	— .01	— .13	— .14	+ .70	+ .26	+ .54	+ .55
Extreme Northwest:								
Moorhead, Minn	+ .94	— .11	— .13	+ .57	+ .29	+ .07	+ .23	— .15
Bismarck, N. Dak	— .62	+ .01	— .20	+ .58	— .31	+ .11	+ .51	+ .14
Fort Buford, N. Dak	— .64	+ .01	+ .02	— .11	— .16	+ .28	+ .68	— .15
Rocky Mountain Slope:								
Fort Assinaboine, Mont	—1.55	— .13	— .09	— .10	— .07	— .07	— .13	— .11
Cheyenne, Wyo	+2.38	+ .10	— .02	+ .63	+ .35	— .27	— .07	+ .37
North Platte, Nebr	+ .25	+ .20	— .14	+ .46	+1.01	— .38	+ .19	+1.23
Denver, Colo	+ .86	+ .01	— .04	+ .57	+2.32	— .42	— .02	+ .64
Dodge City, Kans	+ .19	+ .50	— .21	+2.42	— .09	— .22	+1.07	+ .71

TABLE II.—*Precipitation departures for the season of 1891 from the normal of many years*—Continued.

Stations.	From Jan. 1 to Mar. 6, inclusive.	For the weeks ending—						
		March			April			
		13.	20.	27.	3.	10.	17.	24.
Pacific Coast:								
Olympia, Wash	—6.98	— .99	— .33	+ .74	— .79	+ .57	— .62	—1.27
Portland, Oregon	—5.57	— .88	—1.10	— .23	— .73	+ .31	— .60	+ .97
Roseburg, Oregon	+4.83	+ .27	— .40	+ .38	— .61	+ .14	— .47	— .21
Red Bluff, Cal	+3.88	— .67	— .67	— .15	— .67	+ .67	+ .32	— .45
Sacramento, Cal	+ .73	— .49	— .57	— .50	— .70	+ .42	+ .27	— .63
San Francisco, Cal	— .01	— .69	— .46	— .13	— .59	+1.09	+ .27	— .47
Los Angeles, Cal	+1.81	— .63	— .34	— .54	— .49	— .09	+ .43	— .37
San Diego, Cal	+1.37	— .33	— .09	— .26	— .25	— .03	+ .25	— .07

Stations.	For the weeks ending—								
	May					June			
	1.	8.	15.	22.	29.	5.	12.	19.	26.
New England States:									
Eastport, Me	— .66	— .82	— .44	— .19	— .82	— .28	— .84	— .75	+ .76
Portland, Me	— .57	— .39	— .52	+1.59	— .37	— .02	— .77	— .44	+ .67
Boston, Mass	— .73	— .68	— .69	+ .25	— .55	— .14	— .77	+ .11	+ .76
Middle Atlantic States:									
Albany, N. Y	— .62	— .48	— .64	+ .51	— .50	— .13	— .89	+1.02	— .85
New York City, N. Y	— .76	— .25	— .54	+ .60	+ .49	— .55	— .35	+ .25	— .71
Philadelphia, Pa	— .63	— .13	— .27	— .25	— .29	— .65	+ .03	+ .21	— .13
Washington City, D. C	— .76	— .23	— .16	— .75	+1.36	— .22	— .61	+ .47	+1.00
Lynchburg, Va	— .78	— .71	+1.13	— .43	— .49	— .58	— .35	— .44	— .44
Norfolk, Va	— .91	— .82	+ .34	— .76	+1.07	— .69	— .72	— .34	— .51
South Atlantic States:									
Charlotte, N. C	— .92	— .98	+3.66	— .80	+1.68	— .77	+1.19	—1.08	— .68
Wilmington, N. C	— .71	— .31	— .85	—1.01	— .71	—1.09	+ .35	— .87	—1.00
Charleston, S. C	— .86	— .54	+ .10	— .59	+ .59	+ .36	— .69	—1.08	—1.02
Augusta, Ga	— .78	— .62	+1.59	— .73	+1.45	— .88	+2.89	— .70	— .75
Savannah, Ga	— .72	— .40	+ .11	— .52	+ .21	—1.42	— .56	—1.01	—1.65
Jacksonville, Fla	+ .02	— .20	— .94	— .96	+ .93	—1.24	+ .44	— .15	—1.14
Gulf States:									
Atlanta, Ga	— .84	— .80	— .72	+ .09	+ .09	— .91	+1.69	—1.02	+ .90
Mobile, Ala	— .95	— .87	— .83	— .94	— .83	—1.31	+ .61	+2.81	— .69
Montgomery, Ala	—1.07	— .94	— .34	+ .18	+ .31	— .81	+1.66	— .50	— .47
Vicksburg, Miss	—1.35	—1.22	—1.08	— .88	— .24	—1.05	+1.34	+1.00	— .82
New Orleans, La	—1.23	—1.13	— .37	—1.19	—1.30	—1.47	—1.11	+1.70	— .95
Shreveport, La	—1.20	— .99	— .99	— .42	— .75	— .93	— .63	— .46	— .48
Fort Smith, Ark	—1.19	+ .54	— .93	— .36	— .39	— .73	— .38	+1.28	+ .05
Little Rock, Ark	—1.13	+ .24	—1.22	— .74	— .91	—1.14	— .20	+ .79	—1.03
Palestine, Tex	—1.23	— .55	—1.45	—1.34	— .90	— .88	— .02	— .79	+ .40
Galveston, Tex	— .78	— .75	— .79	— .99	—1.08	—1.17	—1.19	—1.12	+ .59
San Antonio, Tex	— .77	— .77	— .04	— .54	+ .70	— .61	+ .25	— .38	+ .35
Ohio Valley and Tennessee:									
Memphis, Tenn	—1.17	— .64	— .84	— .76	+ .25	—1.17	+1.15	+ .82	—1.00
Nashville, Tenn	—1.05	— .65	— .78	— .26	+ .84	— .89	+3.46	— .52	— .13
Chattanooga, Tenn	— .67	— .97	— .94	— .58	— .43	—1.03	+1.87	+2.85	— .58
Knoxville, Tenn	— .79	— .79	— .09	— .78	— .39	— .74	+ .90	+ .21	— .89
Louisville, Ky	— .97	— .40	— .84	— .20	— .61	— .25	— .63	— .98	— .56
Indianapolis, Ind	— .75	— .85	— .80	+ .14	— .70	+ .02	— .90	— .65	— .86
Cincinnati, Ohio	— 64	— .62	— .71	— .53	— .25	+1.01	+ .32	— .81	— .17
Columbus, Ohio	— .81	— .95	—1.12	+ .29	+ .13	+ .03	+ .84	— .22	+ .20
Pittsburg, Pa	— .59	— .52	— .76	+ .53	+ .08	+ .32	+ .11	+ .22	+ .78
Lake Region:									
Oswego, N. Y	— .50	— .31	— .56	— .01	— .41	— .39	— .13	— .48	— .60
Buffalo, N. Y	— .64	— .33	— .69	— .31	— .25	— .48	— .82	— .46	+ .18
Cleveland, Ohio	— .36	— .59	— .69	+ .87	— .02	+1.00	+ .29	— .70	— .25
Detroit, Mich	— .61	— .22	— .31	— .12	— .79	— .39	— .78	— .24	+ .02
Alpena, Mich	— .57	— .81	— .83	— .74	— .86	— .35	— .81	+ .80	— .82
Grand Haven, Mich	— .64	— .64	— .60	+ .25	— .79	+ .93	— .95	.00	— .78
Milwaukee, Wis	— .70	— .70	— .66	+ .47	— .74	+2.13	— .83	+ .25	— .39
Chicago, Ill	— .75	— .35	— .64	+ .54	— .90	— .09	— .77	— .19	— .86
Duluth, Minn	+ .02	— .64	— .69	+1.26	— .99	— .73	—1.24	— .49	— .62
Upper Mississippi Valley:									
St. Paul, Minn	— .61	— .68	— .68	— .48	— .76	+ .10	— .90	+ .50	— .27
La Crosse, Wis	— .61	— .63	— .63	— .59	— .72	+ .04	— .97	+1.46	— .32
Davenport, Iowa	— .82	— .70	— .42	+ .60	— .94	— .08	— .45	+ .05	— .79
Des Moines, Iowa	— .79	— .95	— .99	+1.54	— .91	— .85	— .80	—1.18	— .30
Springfield, Ill	— .96	— .65	— .60	— .44	—1.26	— .59	— .80	—1.29	— .33
Cairo, Ill	— .74	+ .79	— .84	— .49	— .59	— .98	+ .55	— .47	+ .66
St. Louis, Mo	— .81	+ .27	+ .02	— .34	— .84	— .72	+1.82	+ .02	— .10

TABLE II.—*Precipitation departures for the season of 1891 from the normal of many years*—Continued.

Stations.	For the weeks ending—								
	May					June			
	1.	8.	15.	22.	29.	5.	12.	19.	26.
Missouri Valley:									
Springfield, Mo	-1.24	- .18	-1.18	- .57	- .36	- .18	+2.08	- .23	+ .74
Kansas City, Mo	- .90	- .73	+ .52	+2.40	- .46	+2.70	- .70	+1.14	- .71
Concordia, Kans	- .73	- .85	- .37	+2.04	- .81	+1.43	- .80	+2.80	- .56
Omaha, Nebr	- .80	- .69	- .88	+1.48	- .64	+1.05	- .50	- .80	+3.12
Valentine, Nebr	- .35	- .35	- .83	- .27	- .91	+ .30	- .57	+1.22	+2.11
Huron, S. Dak	- .31	- .67	- .77	- .61	- .62	+ .04	- .84	+3.80	- .72
Extreme Northwest:									
Moorhead, Minn	- .45	- .52	- .44	+ .03	- .56	+ .99	- .80	- .29	+ .71
Bismarck, N. Dak	- .56	- .53	- .08	+ .60	- .09	+1.00	- .38	+1.09	- .40
Fort Buford, N. Dak	- .17	- .16	- .18	- .37	- .47	+1.84	+ .87	- .08	+2.06
Rocky Mountain Slope:									
Fort Assinaboine, Mont	+ .51	+1.81	+ .13	- .05	- .09	+ .15	- .12	+1.65	- .10
Cheyenne, Wyo	- .41	- .49	+1.25	+1.02	+1.00	- .27	- .40	+ .53	+ .44
North Platte, Nebr	- .41	- .62	- .62	+ .74	- .70	+ .89	- .35	+2.65	+ .35
Denver, Colo	- .57	- .07	- .13	+1.76	+ .63	+ .97	- .32	+ .80	- .04
Dodge City, Kans	- .63	- .74	- .77	+1.35	+ .26	+1.33	+ .08	+1.96	- .31
Pacific Coast:									
Olympia, Wash	+ .67	+1.25	- .50	- .49	- .48	+ .11	- .03	+1.78	+ .21
Portland, Oregon	+ .27	+1.03	- .55	- .55	- .37	- .28	+ .71	+1.02	- .81
Roseburg, Oregon	- .40	+1.78	- .40	- .35	+ .38	+ .68	+ .76	+ .15	- .01
Red Bluff, Cal	- .48	+ .09	- .26	- .21	+ .36	+ .27	+ .18	+ .09	- .11
Sacramento, Cal	- .51	+ .17	- .19	- .14	- .03	+ .01	- .02	- .07	- .01
San Francisco, Cal	- .36	+ .36	- .14	- .14	+ .51	- .03	+ .04	- .07	- .07
Los Angeles, Cal	- .23	- .12	- .07	+ .23	- .07	- .07	- .07	- .01	.00
San Diego, Cal	- .17	- .11	- .06	+ .24	- .07	- .02	- .01	.00	.00

Stations.	For the weeks ending—								
	July					August			
	3.	10.	17.	24.	31.	7.	14.	21.	28.
New England States:									
Eastport, Me	- .51	+ .66	- .92	- .48	- .50	- .77	+ .46	- .64	+1.51
Portland, Me	- .50	+1.01	+ .50	.00	- .09	- .74	- .84	- .66	- .04
Boston, Mass	- .77	+ .56	- .72	+ .09	+ .54	- .32	- .67	- .60	+1.05
Middle Atlantic States:									
Albany, N. Y	- .86	- .15	- .12	+1.87	+ .87	+ .05	- .62	+1.07	+1.97
New York City, N. Y	- .84	+ .05	- .94	+ .05	+ .70	- .26	- .64	- .45	+2.39
Philadelphia, Pa	- .66	+ .92	- .90	- .51	+ .83	- .14	- .49	- .34	+ .11
Washington City, D. C	+1.44	+ .60	+ .39	+ .64	+ .08	- .88	- .66	+ .07	+1.10
Lynchburg, Va	- .08	+ .68	- .84	+1.99	- .31	+ .91	- .82	+ .01	+2.02
Norfolk, Va	- .92	+ .78	+1.41	+ .94	+ .48	- .34	-1.31	- .31	+1.64
South Atlantic States:									
Charlotte, N. C	- .47	- .21	- .81	- .12	- .57	- .29	-1.16	- .32	+3.09
Wilmington, N. C	- .60	-1.16	- .52	+ .25	+ .60	+3.64	-1.30	-1.49	+2.81
Charleston, S. C	- .08	-1.32	-1.63	+3.35	+ .66	-1.40	-1.24	-1.63	+2.25
Augusta, Ga	- .66	- .88	-1.17	+ .35	+3.05	+ .03	+ .26	- .32	+3.48
Savannah, Ga	-1.24	+ .43	- .77	+2.86	+2.57	- .16	+ .39	-1.64	+6.19
Jacksonville, Fla	-1.15	- .60	+ .54	- .62	-1.24	-1.32	- .09	- .85	- .26
Gulf States:									
Atlanta, Ga	-1.04	+ .83	+ .64	- .95	+1.45	- .56	- .57	- .05	- .68
Mobile, Ala	- .88	+2.37	- .36	- .65	- .13	+ .17	- .09	-1.27	-1.40
Montgomery, Ala	+1.86	+ .18	- .13	- .84	+ .57	+ .43	+ .01	- .46	- .56
Vicksburg, Miss	- .98	+1.64	+ .39	- .57	- .63	- .31	- .49	- .78	- .73
New Orleans, La	-1.44	+ .98	-1.05	- .80	- .52	- .27	-1.29	-1.27	-1.18
Shreveport, La	- .53	+ .57	- .23	- .82	- .30	+ .53	.00	- .40	- .53
Fort Smith, Ark	- .64	- .81	+ .24	- .05	+7.12	- .85	+ .77	- .85	- .78
Little Rock, Ark	- .84	+ .29	+ .63	- .74	+5.98	+ .11	- .77	- .46	+ .14
Palestine, Tex	- .70	+1.00	- .35	- .62	+ .35	+ .27	+1.79	- .25	- .58
Galveston, Tex	+ .56	+2.28	+ .17	- .28	- .47	- .98	- .90	- .97	+2.01
San Antonio, Tex	- .61	- .53	- .44	- .09	- .66	- .19	- .77	- .79	- .41
Ohio Valley and Tennessee:									
Memphis, Tenn	+ .21	+ .62	- .40	- .58	+3.65	- .06	- .82	- .33	+ .18
Nashville, Tenn	- .32	- .11	- .63	- .84	- .79	- .04	- .75	+1.25	+ .05
Chattanooga, Tenn	- .54	+ .73	- .39	- .35	+2.83	+1.38	- .78	- .80	- .46
Knoxville, Tenn	- .94	+ .83	- .02	- .57	+ .50	+ .10	- .53	+ .04	- .61
Louisville, Ky	- .48	.00	- .80	+1.84	- .42	+2.38	- .66	- .06	- .36
Indianapolis, Ind	- .50	+ .09	- .98	- .67	- .87	+ .60	- .59	+2.46	- .12
Cincinnati, Ohio	- .23	+1.71	- .18	- .41	+ .84	- .70	- .91	+ .19	+ .41
Columbus, Ohio	+ .47	+ .61	- .03	+ .35	+ .77	- .54	+ .08	- .18	+ .10
Pittsburg, Pa	+ .8[illegible]	+ .45	- .07	+ .91	+ .09	- .68	- .23	- .30	- .29

TABLE II.—*Precipitation departures for the season of 1891 from the normal of many years*—Continued.

Stations.	For the weeks ending— July 3.	10.	17.	24.	31.	August 7.	14.	21.	28.
Lake Region:									
Oswego, N. Y	−.38	+.29	−.54	+.36	+.62	−.40	−.13	+.16	+.14
Buffalo, N. Y	−.13	+.70	−.37	+.06	+.21	−.60	+.75	−.06	+.15
Cleveland, Ohio	−.41	−.43	−.78	−.61	−.59	−.70	+.85	−.57	+.24
Detroit, Mich	−.04	+.20	−.39	+.09	−.77	−.70	−.03	−.06	+.15
Alpena, Mich	+.44	−.71	−.63	−.34	−.37	−.46	+2.13	+.85	+1.14
Grand Haven, Mich	−.31	+.20	−.53	−.06	−.62	−.62	−.62	−.21	−.06
Milwaukee, Wis	−.12	+.67	−.16	−.33	−.17	−.70	−.64	+.22	+.96
Chicago, Ill	+.25	+.38	−.09	−.82	−.78	−.65	−.40	+.38	+2.45
Duluth, Minn	+.43	−.91	+1.29	+.15	−.53	+.02	−.58	.00	−.61
Upper Mississippi Valley:									
St. Paul, Minn	+.56	+.53	+.37	−.53	−.55	−.84	+.42	+1.04	−.67
La Crosse, Wis	+.63	−.08	−.09	−.12	−.84	−.61	−.63	−.09	−.85
Davenport, Iowa	−.12	+1.27	−.50	−.08	−.84	+.28	+1.25	+1.01	−.60
Des Moines, Iowa	−.04	−.80	−.45	+1.49	−.70	−.16	+.48	+1.41	−.61
Springfield, Ill	−.83	+.14	+2.25	−.37	+.49	+.30	+2.00	+.44	−.15
Cairo, Ill	−.98	+.23	−.49	−.41	−.34	−.26	+.27	+2.69	−.47
St. Louis, Mo	−.81	+.20	−.43	−.69	−.65	−.15	+.43	+.58	−.38
Missouri Valley:									
Springfield, Mo	−1.02	+.15	+.33	+.15	+.50	−.71	−.67	+2.46	−.94
Kansas City, Mo	−.43	−.01	−.14	−.48	−.86	+.54	−.97	+3.73	−1.00
Concordia, Kans	+.15	+.07	−.18	+.09	+.06	−.90	−.72	−.67	−.74
Omaha, Nebr	−1.34	−.51	−.50	−.95	−.29	−.30	−.69	+.56	−.63
Valentine, Nebr	−.28	+1.51	−.48	−.16	+.67	+.59	+.41	+2.25	+.12
Huron, S. Dak	+1.56	−.90	−.69	−.08	−.82	−.50	+.07	−.56	−.35
Extreme Northwest:									
Moorhead, Minn	−.75	−.77	+1.04	−.01	−.65	+.22	−.40	+.76	−.57
Bismarck, N. Dak	−.45	+.40	+1.35	−.15	+.26	+.48	−.40	−.26	−.45
Fort Buford, N. Dak	−.21	+.31	+.80	−.40	+.44	−.35	−.29	+.26	−.04
Rocky Mountain Slope:									
Fort Assinaboine, Mont	−.05	−.43	+3.13	−.44	+.18	+1.11	−.29	−.33	−.29
Cheyenne, Wyo	−.22	−.26	−.15	−.30	−.14	−.26	−.24	+1.37	−.15
North Platte, Nebr	−.02	+.72	−.11	+.67	+.01	−.63	−.01	+.40	+.43
Denver, Colo	−.16	−.27	−.37	−.32	+.06	+.12	−.35	+1.45	−.22
Dodge City, Kans	−.51	+1.11	−.34	+.28	+1.30	−.65	+.32	−.69	−.54
Pacific Coast:									
Olympia, Wash	−.28	−.02	−.17	−.14	−.14	+.78	−.14	+.30	−.18
Portland, Oregon	−.26	−.03	−.01	−.14	−.14	+.65	−.14	.00	−.14
Roseburg, Oregon	−.25	+.62	−.06	−.07	−.07	−.13	−.06	+.16	−.07
Red Bluff, Cal	−.06	+.16	+.01	.00	.00	.00	.00	.00	.00
Sacramento, Cal	.00	.00	.00	.00	.00	.00	.00	.00	.00
San Francisco, Cal	−.01	−.09	+.01	.00	−.02	−.01	.00	.00	.00
Los Angeles, Cal	.00	.00	.00	.00	−.03	−.05	.00	.00	.00
San Diego, Cal	.00	.00	.00	.00	−.01	−.07	−.07	−.01	.00

Stations.	For the weeks ending— September 4.	11.	18.	25.	Oct. 2.
New England States:					
Eastport, Me	−.19	+1.41	−.51	−.87	−.92
Portland, Me	−.58	+.09	+.04	−.70	−.66
Boston, Mass	−.37	+1.28	−.64	−.66	−.79
Middle Atlantic States:					
Albany, N. Y	−.50	+.02	−.23	−.84	−.75
New York City, N. Y	−.40	+.72	−.82	−.90	−.56
Philadelphia, Pa	−.20	+.75	−.79	−.76	−.47
Washington City, D. C	−.15	+1.43	−.84	−.89	−.61
Lynchburg, Va	−.83	+.06	−.79	−.54	−.73
Norfolk, Va	−.85	−.33	−.37	−1.07	−.11
South Atlantic States:					
Charlotte, N. C	−.37	−.69	−.48	−.75	−.86
Wilmington, N. C	+1.03	−1.08	−1.17	−1.50	+3.86
Charleston, S. C	+.67	+1.13	−.77	−1.39	+3.62
Augusta, Ga	+.79	−.77	−.80	−.89	−.43
Savannah, Ga	−1.32	−.77	−1.48	−1.28	+1.23
Jacksonville, Fla	−.74	+5.19	−.89	−1.89	+1.83
Gulf States:					
Atlanta, Ga	−.39	−.60	−.81	−1.01	−.70
Mobile, Ala	−.31	+.52	−.53	−.74	−.79
Montgomery, Ala	−.45	+.99	−.75	−.71	−.59
Vicksburg, Miss	−.91	−1.10	−1.00	−.76	−.56

Table II.—*Precipitation departures for the season of 1891 from the normal of many years*—Continued.

Stations.	For the weeks ending—				
	September				Oct. 2.
	4.	11.	18.	25.	
Gulf States—Continued.					
New Orleans, La	−1.05	− .61	−1.16	+1.36	− .62
Shreveport, La	+ .25	−1.06	−1.11	− .96	+3.22
Fort Smith, Ark	− .30	− .42	− .77	− .73	− .71
Little Rock, Ark	− .08	− .91	− .82	− .72	− .56
Palestine, Tex	− .35	− .72	− .80	− .49	− .02
Galveston, Tex	−1.61	−1.85	− .64	+3.46	− .40
San Antonio, Tex	−1.01	−1.11	+ .33	+ .47	+ .27
Ohio Valley and Tennessee:					
Memphis, Tenn	+ .27	− .64	− .79	− .77	− .75
Nashville, Tenn	− .39	− .39	− .92	− .88	− .76
Chattanooga, Tenn	+ .28	− .86	− .63	− .98	− .81
Knoxville, Tenn	− .01	− .77	− .09	− .70	− .59
Louisville, Ky	+ .38	− .07	− .69	− .63	− .47
Indianapolis, Ind	− .37	− .37	− .63	− .68	− .41
Cincinnati, Ohio	+1.11	− .06	− .56	− .49	− .09
Columbus, Ohio	+ .47	− .35	− .37	− .59	− .39
Pittsburg, Pa	− .09	+ .06	− .39	− .61	− .16
Lake Region:					
Oswego, N. Y	+ .17	− .30	− .50	− .70	− .62
Buffalo, N. Y	− .38	− .62	− .02	− .76	− .32
Cleveland, Ohio	− .48	+ .53	− .50	− .88	− .77
Detroit, Mich	+ .26	+ .34	− .63	− .57	− .26
Alpena, Mich	+ .65	− .93	+ .24	− .98	− .82
Grand Haven, Mich	− .47	− .84	− .10	− .89	− .88
Milwaukee, Wis	− .24	− .68	− .70	− .70	− .54
Chicago, Ill	− .43	− .64	− .62	− .70	− .68
Duluth, Minn	+ .16	− .54	− .54	− .68	+1.50
Upper Mississippi Valley:					
St. Paul, Minn	− .45	− .76	− .70	− .73	+ .15
La Crosse, Wis	− .73	−1.22	+ .08	−1.00	+ .54
Davenport, Iowa	− .57	− .69	+ .10	− .77	− .16
Des Moines, Iowa	− .81	− .82	+ .04	− .21	− .42
Springfield, Ill	− .68	− .77	− .81	− .84	+ .46
Cairo, Ill	− .34	− .63	− .62	− .56	− .56
St. Louis, Mo	− .37	− .83	− .73	− .74	+ .30
Missouri Valley:					
Springfield, Mo	− .50	− .06	− .79	− .77	− .73
Kansas City, Mo	−1.06	− .82	−1.05	− .99	− .89
Concordia, Kans	− .16	+1.09	− .56	− .56	+1.93
Omaha, Nebr	+ .25	− .67	− .66	− .28	+1.39
Valentine, Nebr	− .28	− .24	− .32	− .05	+ .85
Huron, S. Dak	− .39	− .35	− .35	− .11	− .03
Extreme Northwest:					
Moorhead, Minn	− .40	+ .80	− .56	+ .89	+ .53
Bismarck, N. Dak	− .23	− .28	− .22	+ .05	+ .71
Fort Buford, N. Dak	− .24	− .21	− .21	− .11	+1.09
Rocky Mountain Slope:					
Fort Assinaboine, Mont	− .12	+ .41	− .28	− .09	+ .05
Cheyenne, Wyo	+ .16	+ .16	− .17	+ .94	+ .21
North Platte, Nebr	− .43	+ .16	− .27	− .31	+ .41
Denver, Colo	− .24	− .18	− .15	+ .38	− .04
Dodge City, Kans	− .37	− .20	+ .17	+1.17	+3.02
Pacific Coast:					
Olympia, Wash	− .33	− .04	+ .71	− .16	+ .25
Portland, Oregon	− .19	− .20	+ .47	− .20	+ .26
Roseburg, Oregon	− .07	− .05	+ .22	− .04	+ .04
Red Bluff, Cal	− .09	− .04	− .07	− .12	− .16
Sacramento, Cal	− .03	− .01	− .05	− .05	− .09
San Francisco, Cal	+ .02	+ .01	+ .05	+ .56	− .09
Los Angeles, Cal	.00	.00	+ .06	− .01	− .09
San Diego, Cal	.00	.00	.00	+ .06	− .07

WEATHER AND CROP CONDITIONS FOR 1891 IN VARIOUS SECTIONS OF THE UNITED STATES.

ALABAMA.

Farming operations begin in Alabama about the 1st of February, although the winters are generally mild enough for some work to be done in December and January. The soil is very seldom so hard frozen at any time during the winter as to prevent plowing and preparation for the planting of certain winter crops.

The weather crop bulletins of this service begin generally the first week in April, because farming operations and the planting of the most important crops have well begun by this time. The first bulletin issued this year was dated April 5. During February and March, however, the cold weather was so severe, following a mild winter, that a large proportion of the fruit was destroyed and but few peaches and plums remained on the trees to ripen. In the second week of April another cold wave passed over the State, and all young corn, vegetables, etc., were killed to the ground and some farmers were compelled to replant. The rainfall throughout April was below the normal, and this condition, together with the cool weather, threw farming operations backward. This drought continuing through the month of May, it was not until the middle of June that fair stands of corn and cotton were secured. During the third week in June the drought was broken by frequent and good showers in all parts of the State, that were greatly beneficial to all crops. Corn and cotton began a vigorous growth from this time, and the season remained very favorable until the 15th of August. In the southern portions of the State half-grown cotton bolls were discovered in the fields on the 20th of June.

The finest crop of corn has been made in Alabama this year that has been gathered in many years. After June 1 the season was most excellent for this crop, and, fortunately for the farmers of the State, quite a large area was planted.

From the 1st to the 15th of August the precipitation was above the normal. From the 15th of August until the middle of September rain fell very seldom; the air became very dry, and crops suffered very much for moisture. The atmosphere was also unusually warm. This dry and hot condition of the atmosphere was so severe that the cotton was badly scorched and the plant was placed in such an unhealthy condition that diseases rapidly set in, and before the 10th of September the young bolls and squares shed to such an extent that the excellent outlook of July 1 was obliterated and the chances for even a fair crop were destroyed. By the 12th it became quite evident in all sections of Alabama that the crop would be reduced fully 25 per cent, if not more. The bad season caused the plant to quit blooming sooner than usual, and a large reduction was made in this way also.

Periods of drought.—April 11 to June 15, and August 15 to September 12.

Wet weather.—June 18 to July 1.

Cool spells.—The months of May, June, and July, and August 23 to August 25.

Warm spells.—August 15 to August 22.

Comparisons between the average precipitation and temperature for certain months in 1891 and the normals for the same period are shown in the following table:

Months.	Temperature.		Precipitation.	
	Normal.	Mean.	Normal.	Mean.
March	54.1	52.9	5.76	3.05
April	63.5	63.3	5.12	1.85
May	73.3	68.3	3.95	2.20
June	77.8	78.5	4.80	4.38
July	83.9	78.6	4.40	5.77
August	78.9	78.8	4.01	2.29
September	79.9	....	2.74	....

ARKANSAS.

From Mr. F. H. Clarke, observer, Weather Bureau assistant director of the Arkansas weather service at Little Rock:

General farming operations began about March 21, although at that time the soil was too wet to make good plowing and too cold to germinate seeds planted.

The excess of precipitation at this date was not great, but showers were frequent, and the average cloudiness was much below the normal; this, together with the low temperature of the early part of the month, prevented the soil from drying out sufficiently to make good plowing, and in some portions seriously injured oats that had been sown.

The cool weather was advantageous in rotarding the development of fruit buds and thus preventing injury by a subsequent killing frost, which occurred throughout the State on April 4, but no serious damage resulted owing to the lateness of the season.

Corn was being rapidly planted during the week ending April 11, which was favorable for all kinds of farm work.

In the southern part of the State cotton-planting became general about April 16, and in all other portions during the following week.

The mean temperature for May averaged about three degrees per day below the normal, and was injurious to cotton in most sections of the State in preventing growth and tending to bring out cut-worms, which did considerable damage.

The dry weather from the 5th to the 17th of May prevented germination of cotton seed planted, and during the following two weeks many acres were plowed up and replanted in corn. At the close of the month cotton was generally clean and well cultivated, and corn was in excellent condition.

Up to the last week of July cotton was in good condition and promised an abundant yield, but during the last five days of the month heavy rains occurred throughout the State, causing bottom lands to become overflowed and seriously damaging the crop. Rust, blight, and shedding prevailed throughout the lowlands; on the uplands, however, cotton was in excellent condition and promised a full crop.

During the week ending August 20 the temperature averaged about five degrees above the normal. Cotton and corn made rapid growth and was recuperating somewhat from the effects of the heavy rains in the latter part of July when, on the 23d, the weather turned suddenly much cooler and during the ensuing week averaged about eight degrees per day below the normal. This cold spell, which continued until the middle of September, damaged the cotton beyond recovery, causing blight, rust, and shedding to prevail to an alarming extent. This, together with the ravages of the boll and cotton worm, it is estimated, has caused the crop to be cut short about 20 per cent.

A general summary of the weather conditions shows that everything was favorable for cotton up to July 27, when the heavy rains occurred, since which time the condition of this crop has steadily fallen off. The quality of cotton is, however, good and above the average.

The weather was favorable for corn during the entire season, and the largest crop has been harvested that has been made in years.

Oats did fairly well and wheat above the average.

CALIFORNIA.

From Mr. James A. Barwick, observer, Weather Bureau at Sacramento:

The peculiarities of the climate of California leaves but little to say, because there is a wet and dry season, and all crops except grain are raised by irrigation in the summer or dry season, and consequently the weather cuts but a small figure in the effects upon crops. Will, however, say that the first part of the spring was excellent for all crops, and continued so until the begining of the hot wave in the last days of June, from which time up to September wave after wave of extreme heat passed over this State, and so continuous were they that it injured both the raisin and the wine grapes, thereby reducing the average yield of both raisin and wine per acre; but with increased acreage the amount of raisin grapes will be about the same as last year, but the wine output will be very much less in the Santa Clara Valley and somewhat less in the Sonoma and Napa valleys. The grasshoppers ruined crops in certain and scattered areas throughout the San Joaquin and Sacramento valleys and the foothill region.

The following data regarding the planting and maturing of the different crops in the great valleys of this State was taken from my annual meteorological report to the State Agricultural Society for the year 1889.

Planting and harvesting time in the Sacramento and San Joaquin valleys.

Kind of crops.	Planting.	Maturing.
Wheat	December and January	June.
Barley	do	June and July.
Oats	January and February	Do.
Corn	February and March	June to August.
Beans	do	May to July.
Peas	do	April to June.
Tomatoes	do	May to June.
Oranges		December and January.

There is very little if any difference in the time of planting and harvesting the above crops in northern or southern California, except oranges, which color and ripen in northern California before they do in southern California, thereby keeping the orange crop from each part of the State coming in competition with each other, and also preventing the glutting of the Eastern and home markets.

Crops near the coast of the Pacific Ocean ripen somewhat later than they do in the interior and warmer valleys, while some of the counties in the higher altitude have their crops ripen and mature much later than the counties that compose the great valleys of the State.

COLORADO.

From Mr. W. S. Miller, observer, Weather Bureau, director of the Colorado weather service:

The late snows and cold weather last spring retarded farm work a great deal. On account of the heavy precipitation during the winter the ground was in excellent condition. April came in with very little seeding or plowing having been done. Fruit buds were held back by the low temperature, thus saving many that would have been killed by frost later on. By April 15 seeding had been about completed and fruit was beginning to blossom; corn and potatoes were planted from April 20 to the beginning of May. Alfalfa at this time was doing extraordinarily well. Toward the beginning of May the hot dry air had crusted the surface, preventing the grain from coming up, but general rains, which fell from the 10th to the end of May, did the ground much good and placed everything in a fine condition. With the wet weather (which was so excessive in some localities as to somewhat damage alfalfa) came a cool spell, which interfered with the growth of corn. By June 5 wheat was stooling, rye heading out, corn much better color and condition, potatoes and fruits doing well, and the first alfalfa crop being cut. Heavy rains during the second decade of June damaged some hay which had been cut but not secured; about this time an immense berry crop was also being harvested. In the Arkansas Valley cutting of wheat began the last few days of June, followed the next week by harvest in eastern and northeastern Colorado. Wheat was just about ripe in northern Colorado when it was damaged by a severe hailstorm. (Of this storm a full report was rendered at the time.) Toward the end of July water was needed, especially for land not under ditch. Fortunately, general rains fell over the State the last few days of that month; there was not much suffering from drought in any section. At the beginning of August all grain had been harvested except in the San Luis Valley, where the season is normally several weeks later than in other sections of this State. The second alfalfa crop was harvested by the 5th of the month under favorable conditions and well secured. The temperature during August was about average, but the precipitation was considerable less than the average, generally; but a general rain fell during the last few days of that month, so there were no ill effects from lack of water. On August 22 and 23 we had light frosts, doing no damage. The first two weeks of September were quite cool, and had a retarding effect on corn and other standing crops, but the warmer weather since the middle of this month have about placed the crops out of danger from early frosts and they are now ripening very rapidly and will yield well. The third crop of alfalfa is now about harvested. The San Luis Valley grain harvest was completed under very favorable conditions by the 20th of September.

Taking the season as a whole the weather has been very good for agriculturists, and the farmers have had a good year in every way. For fruit we had an exceptionally good year. Sections of the State which are unfortunately located as to water supply raised good crops this year.

ILLINOIS.

From Mr. John Craig, observer, Weather Bureau, in charge of the Illinois weather service at Springfield:

Temperature.—Between the dates March 14 and September 12, 1891, the temperature was below the normal throughout the State sixteen weeks. At the central office the deficiency ranged from 2 degrees to 9 degrees daily. During the following dates the temperature was above the normal: Weeks ending April 16, 23; May 1; June 15, 19, and 26, and August 21; and normal for the weeks ending May 15 and 22; June 11, and July 3. Light frosts occurred during April, but did no damage. Frosts again occurred on May 6, 7, 17, and 27, and did considerable damage to small fruits and tender vegetables.

Rainfall.—The rainfall generally was badly distributed throughout the State during early part of season. During July the drought was unusually severe in the central and southern counties, but after that time the precipitation was generally well distributed over the counties where it was so badly needed.

Wheat.—The seeding of wheat begins during September and is generally harvested about the end of June. The condition of this crop from the first has been good and the weather conditions affected it very favorably, little damage being done by the drouth or fly. Wheat seeding has commenced in the central and southern counties, the ground being in fairly good condition.

Corn.—The seeding of corn begins during May and it is generally ready to harvest between October 15 and November 1. At the present time it is safe to say that at least 70 per cent of it is out of danger from frost, and the remainder will be by October 1. This crop has been retarded by the continued cool weather of the present season. If a killing frost does not come before October 1 the corn crop of the State will be one of the largest ever raised.

Oats.—The planting of oats begins about May 1 and it is generally ready to harvest by July 15. The grain suffered somewhat from insects and the drought which prevailed during July, and considerable of it was damaged by heavy rains which caused it to lodge. This crop will be lighter than usual, but the quality is good.

Fruits.—Strawberries were badly nipped by the frosts which occurred during May, but the crop raised was up to the average. With the exception of apples, the fruit crop was above the average.

INDIANA.

From Prof. H. A. Huston, director, and C. F. R. Wappenhans, Weather Bureau, assistant director, Indiana weather service:

The winter was mild and open throughout, and wheat wintered well. During March, when exceedingly cold weather occurred, wheat was protected by a covering of snow, but the cold weather retarded the development of fruit buds. The heavy rains during the latter part of March and the early part of April delayed plowing, the seeding of oats, rye, potatoes, and tobacco. The latter part of April was more favorable to farm work and crops, and at the close of the month peaches, pears, and plums were in full bloom. The light frosts during the early part of May caused no injury, and fruit and crops did well. About the middle of the month some corn was planted, although the ground was very dry, but during the latter part of the month the weather was more favorable and nearly all the corn crop was planted and oats had improved. In early June much rain fell; wheat was in fine condition, clover ripened, corn grew rapidly, and fruits promised a great yield; strawberries were abundant, but oats seemed almost a complete failure. About middle of June smut and the grain aphis made their appearance in some localities; wheat matured rapidly, and harvesting began in the southern portions of the State on the 13th. By this time oats had improved and was heading, corn was growing rapidly, clover was cut, and berries were plentiful. At the end of June all wheat was in the shock; thrashing had commenced, and oats and rye were being harvested; corn continued to grow rapidly. At the beginning of July farmers began to secure a good hay crop; the oat crop proved short; the peach crop was very heavy. The rain and cool weather about the middle of July retarded the growth of corn, but tobacco grew well. At the end of July potatoes and watermelons were in fine condition; there was an absence of destructive insects.

During the early part of August corn, potatoes, and pastures needed rain, and fears were entertained of serious injury, but the copious rains of the middle of the month benefited all crops and placed the soil in better condition for plowing. There was an abundant melon crop. The rains that fell toward the end of August benefited the crops and the ground continued in excellent condition for plowing; at the close of the month most of the fields were ready for seeding. September began with dry cool weather. At this time the corn planted in the latter part of May was still green and milking; pastures were in excellent condition; and an increased acreage had been prepared for wheat seeding, but little wheat had been sown. About the middle of September hot and dry weather prevailed and proved very favorable to corn, which matured so rapidly that by September 20 most of corn was safe from injury by frost, and in a few days after the date mentioned the entire corn crop was safe. Tobacco was cut about the 20th of September. The quantity, quality, and perfect condition of the tobacco crop of 1891 has not been equaled in past years.

Upon the whole the weather during the crop season of 1891 was very favorable, and, with the exception of oats, there was an abundant yield of an excellent quality of all crops, and in consequence great prosperity prevails in Indiana.

IOWA.

From Mr. J. R. Sage, director of the Iowa weather and crop service, Des Moines:

Despite its many drawbacks and periods of discouragement, the season of 1891 brought the most bountiful crops ever garnered by the farmers of Iowa.

March was unusually cold and wet, and though the moisture was greatly needed, the roads were well-nigh impassable and the fields were generally too wet for plowing and seeding until about the 6th of April. The season was two to three weeks late at the outset, and the same conditions continued until its close.

During the first half of April the weather was cool and cloudy, but the latter half brought more favorable conditions of heat and moisture, giving a remarkable impetus to plant growth and greatly improving the crop situation. The temperature and precipitation of the month averaged somewhat above the normal. Considerable seeding of small grain was done during the month, and in some sections corn-planting was begun about the 25th. Grass was well started, and the month was favorable for meadows, pastures, winter wheat and rye, and small grain crops.

May was cool and dry. There were frequent light frosts in nearly all sections of the State, but no damage resulted except a general retarding of the crops. There was very little precipitation until about the 20th, and the drought quite seriously affected timothy and early-sown oats. At the close of the month, however, the crop outlook was much better than at the corresponding period in 1890. Corn-planting was generally completed before the 1st of June, but considerable replanting was necessitated by the depredations of cut and wire worms.

June was characterized by extremes of temperature and local excesses of rainfall, causing floods and damage to crops; but on the whole it was favorable to grass and small grain, and corn made fair progress. The average temperature was about normal, and there were no damaging frosts. In many localities the excessive moisture interfered greatly with the cultivation of corn, and the weeds gained a temporary advantage. The crop was two weeks late at the close of the month.

The daily average temperature of July was about 6 degrees below the normal, making it the coolest July within the past twenty years. The average rainfall was about normal, and it was fairly well distributed. A very damaging hailstorm on the 1st passed over a narrow belt from Cherokee to Decatur counties, the area of destruction being at least 100 square miles. Despite frequent showers and an unusual degree of cloudiness, fair progress was made in securing the hay and ripened grain crops, and the yield was exceptionally heavy in nearly all parts of the State. The condition of corn, however, was not promising at the close of the month, the cool weather being unfavorable to its rapid growth. But it made a good stand and its color was good.

The first half of August was warm, and growing crops made fair progress. The last week in the month, however, was abnormally cold, and light frosts were reported in every county in the State, but the resultant damage was light. The cool weather checked the ripening of corn, and the prospect at the close of the month was not promising.

September, by an average daily excess of 5° grandly compensated for the deficiency of temperature during the summer months. It was the warmest and altogether the finest September ever known in Iowa, and at its close every acre of corn was practically safe and sound. The first killing frost occurred on the morning of October 5.

All in all, the year of grace 1891 gave the farmers of Iowa the best all-round crop season ever known since the soil was turned by the plowshare of civilized man.

KANSAS.

From Mr. T. B. Jennings, observer, Weather Bureau at Topeka, in charge Kansas weather service:

The cold weather and large amount of snowfall in March, although generally beneficial to wheat and rye, prevented preparation of the ground for spring crops. The month of April opened cool, with much cloudiness, the first week giving much rain in the central and western counties, while the northern and southern remained deficient.

By the 10th of April much plowing had been done, oat sowing was in progress, and the prairie grass had made a good start. By the 18th the oats were generally sown, and in the south the corn was generally planted, while the wheat and rye had their excellent progress. This week gave us some warm weather, which continued through the following week, by which time the oats were making a fine start all over the State; cherry and peach trees were in full bloom, and all vegetation had made a phenomenal growth. In the extreme southern counties corn was 6 inches high, wheat 10 to 15, while rye was heading out.

By May 1 the prairie grass was furnishing good pasture for all stock. The large rainfall during the first half of April, followed by the warm weather in the last half, made a rapid growth in all crops, which, however, received quite a check during the dry weather of the first half of May. In the southern counties the wheat began

heading the first week in May, while strawberries ripened the second week; this week the drought was broken by abundant rains in the west and northwest counties, which became general over the State during the succeeding week. On account of the dry weather during the first of the month the cool weather proved beneficial to all crops, but during the last half it was a detriment. The abundant rains and cool weather continued through the rest of the month, giving great impetus to wheat, rye, oats, grass, and fruits, but retarding corn and the vegetable garden. Home-grown strawberries began supplying the tables of the central counties during the fourth week of May, and the tame grasses were ready for the first cutting.

The first week in June gave us a continuation of the wet weather, but with the temperature much more seasonal, and corn commenced making a rapid growth; wheat harvest began in the southern tier of counties this week. The second week in June the farmers were enabled to get into their cornfields in a large part of the State. Rains stopped the wheat harvest in the central counties the third week, while the crop conditions in the western counties were most excellent; during this week a "dry spell" extended through the southern tier of counties west of Chautauqua, and during the week ending July 4 moved into the counties east of Harper, yet through the greater part of the State the first week in July was the great corn week of the season, the weather having become more nearly normal in all its departments. Rye harvest ended in the eastern counties. During the second week in July peaches and apples were marketed in abundance in central and southern counties; small fruits abundant in all parts except the newest, and corn grew rapidly. The third week the dry weather narrowed to Elk, Wilson, Montgomery, Labette, and Cherokee; the State generally was well watered, especially in the central counties; corn in tassel, much of it in silk. The next week was a good one for general purposes; wheat harvest over, oats harvest nearly so, flax harvest begun, haying in progress. The drought continued in the southeast the rest of the month, with cool, cloudy, and wet weather in the rest of the State, and corn growing rapidly.

The first week in August gave an entire change over the State, a greatly diminished rainfall and much more sunshine, yet a lower temperature; the drought in the southeastern counties extended over the larger part of the southern half of the State, but during the second week was reduced to the counties south of Miami, Coffey, and McPherson and east of Stafford, Kingman, and Comanche; high temperature and much sunshine this week. In the western counties rains put the ground in good condition for fall plowing; in the southeastern counties the long-continued drought (this being the seventh week), coupled with the high temperature, began to affect not only the corn, but also the shade trees; hay crop is proving the best for some years. Hot, dry weather prevailed during the third week of August, until the last two days, when the temperature rapidly fell, snow falling for some minutes during the middle of the afternoon of the 21st near the central part of Ottawa County. The dry, hot weather this week was favorable for the early corn, but unfavorable to the late corn, the former being nearly matured. The drought was broken this week in Labette and Cherokee, but too late to benefit except fall plowing and renew stock-water.

Cold, dry weather characterized the fourth week in August, except in the western and extreme eastern counties, where good rains fell; frosts occurred on Sunday and Monday, but too light to do damage. The continued dry weather began to shorten the late corn crop by too early maturing; at the close of the week the hay crop had been very generally secured.

The first of September was a continuation of the dry, cool weather of the preceding week; corn-cutting was vigorously pushed to save the fodder. Good rains in the western and northwestern counties during the second week in September gave new life to the late corn there, and enabled fall plowing to be successfully pushed.

KENTUCKY.

From Mr. Frank Burke, observer Weather Bureau at Louisville. In charge Kentucky weather service:

The mildness of the winter 1890-'91 greatly favored the condition of fall grains and grasses and left the fruit trees of all kinds in excellent order at the opening of the present season. Plowing was generally commenced about March 10, though the heavy rains which fell for some time previous to that date rendered the ground unfit for cultivation in the bottom lands. The season was, upon the whole, very unfavorable up to May 10. Excessive rain and lack of sunshine retarded all farm work. To these detriments were added heavy, and in many parts of the State damaging, frosts from May 4 to 7. Though the injury from these was not so great as was at first anticipated, they served as a setback to all crops, particularly to fruits. Unfavorable weather conditions delayed the completion of corn-planting until May 10.

Following these conditions came a period of excessive dryness. For a time it

operated to the advantage of crops, but by the 1st of June it had assumed the character of a serious drought, from the results of which the small grain crops never fully recovered. The seasonal precipitation, which on May 1 showed an excess of 0.87 inch, was on May 31 1.37 inches less than the normal. This deficiency was gradually increased until July 15, when it attained a maximum of 5.01 inches. From that date to the present time (September 15) the seasonal deficiency has diminished to 1.64 inches. The seasonal temperature has throughout the season shown a large excess. This is attributable, in the main, to the unusual clemency of the earlier months of the year. The crop season was, upon the whole, uncommonly cool, and during the months of July and August abnormally so. There were no protracted periods of excessive heat, the highest temperature of the season being 93°, on August 10. The amount of sunshine received during the season was probably in excess of the normal, and it was the one condition entirely favorable to crop progress.

The effect of the weather conditions outlined was, except in the cases of a few crops, very deleterious. The exceeding dryness prevailing at the usual time for the setting out of tobacco, about June 10, compelled growers to keep the plants in their original beds until in many cases they became too large for safe transplanting, and in consequence the crop was not in the ground before June 30. This fact, combined with the failure of the young plants to take root rapidly, has been a serious drawback to the crop, and at the present time it is probably ten days late and promises only a fair harvest. Corn-planting was likewise delayed through the dryness of the weather, and for some time after it sprouted the outlook was far from promising. Since then it has recovered from this drawback, and will doubtless be the largest crop ever harvested in the State, barring damage from early frost, to which it is more than usually exposed, owing to the cool damp weather of August retarding its progress towards maturity.

The crop of small grains was considerably smaller than the average. This is particularly true of oats, which in many sections was a total failure. The harvest was completed July 15, and the period of dry weather preceding this time cut the grain short and withered it before it had attained its normal size. The outlook for wheat early in the season, and for a month previous to harvest time, June 20 to 30, was most excellent. The same causes which operated against the success of the oat crop injured this grain, but owing to the earlier date of the harvest their effects were not so serious. Generally speaking, less than an average crop was harvested, though the reports as to the amount in the different parts of the State are by no means uniform; some sections, which had been favored by local thundershowers during the early part of June, reporting more than an average yield, while in other districts deficiencies as great as 50 per cent existed.

Fruits and vegetable crops are generally very fine. The former suffered some injury from the early frosts, but the yield indicates that the effects were not serious.

It is yet too early to predict accurately the character of the hemp crop, but from all indications it will be excellent.

The past season has been unusually free from destructive insects. Apart from some few reports early in the season of the presence of bugs in tobacco, no complaints have been made.

The existing weather conditions are the most favorable of the season for the crops yet unharvested; tobacco has been vastly improved in the past ten days, and corn is making rapid strides toward maturity. In all probability, the latest planted of the former crop will be cut and housed by October 12; the latter is practically out of danger from frost, and by the 25th instant will be fully harvested.

LOUISIANA.

From Mr. George E. Hunt, local forecast official Weather Bureau director of the Louisiana weather service at New Orleans:

The weather as related to crops in Louisiana from March 1 to September 12, 1891, was divided into three distinct periods: The first, embracing the months of March, April, and May, decidedly unfavorable; the second, from first week of June to August 22, decidedly favorable; while the third, from August 22 to September 12, was unfavorable, but to a less marked extent than the first.

The protracted drought which affected the entire State from the beginning of March to the first week in June came perilously near causing a complete failure in all crops. Cotton and rice planting were delayed, much replanting made necessary, and complaints of poor stands of cotton were general. Sugar cane and corn, having been planted previous to March, were not affected as to stands, but suffered severely for moisture. Sugar cane never entirely recovered and the plant is still small and backward, not yet having attained its proper growth. Temperature and sunshine conditions were generally favorable during the drought period, and planters took advantage of the absence of wet weather to keep their crops in an excellent state of culti-

vation. There were several rather notable cool spells during March and April, but beyond slightly retarding the growth of young cotton there is no evidence that they caused any damage.

The drought was broken during the first week in June by general rains, which were succeeded by well-distributed showers of almost daily occurrence over all portions of the State, and these conditions, accompanied as they were by warm weather and sufficient sunshine and extending up to August 22, were the salvation of the crops, and but for the unfavorable turn of affairs that was ushered in with the phenomenal cool wave of August 22 would have turned what promised to be a most disastrous farming year into one of the most prosperous ones that the State has ever known.

The extent of the injury to crops from the cool and dry weather of the period from August 22 to September 12 is yet problematical, but that there will be a serious falling off in the yield of cotton and sugar is beyond doubt.

Conditions have been all that could be desired for harvesting rice, and planters have been enabled to gather their cotton as rapidly as it opens, thus avoiding dirt and stain in the latter crop.

MARYLAND.

From Dr. C. P. Cronk, observer Weather Bureau in charge of the Maryland weather service:

The opening of the agricultural season of 1891 was not propitious. March was a cold wet month. The minimum temperature of the winter, 15.6°, occurred on the 2d, and on the 15th there was another drop to 21.1° The total precipitation, 7.94 inches, was in excess of any previous record for the same month, and the snowfall itself, 20.5 inches, was the maximum monthly fall for the winter. Snow or rain fell on twenty-one days. Spring work was retarded and general farming operations did not begin until March 30. The cool weather checked the rapid development of fruit and the growth of all other vegetation.

The first part of April was also cold, and minimum temperatures of 30° and 32° were recorded on the 5th and 6th, respectively. The season thus far was about three weeks late and apparently unfavorable, but it was doubtless beneficial in preventing the too rapid development of fruit and its subsequent injury from the cold weather and frosts. After the cold weather of April 5 to 9 farming operations proceeded. Ground was prepared without interruption and seeding progressed rapidly. The doubt in regard to the peach crop of Maryland and Delaware was over by April 25, the petals by that time having fallen away, leaving the embryo peaches in a condition to withstand a considerable frost without serious results. There was every indication at the close of the month that the crop would be a full one.

During the last part of April and the first part of May the rainfall was very slight and crops suffered somewhat from drought. The early part of May, besides being dry, was cold, and northwest winds prevailed. Frost occurred on the morning of the 6th, and though harmless in most sections it did considerable damage in some. In eastern Maryland Irish potato tops were on some lands killed to the ground. Over considerable territory strawberries, pears, beans, cucumbers, and melons were reduced to half crops. On the 17th another light frost occurred in favorable localities, but no damage resulted. Light rains fell every day from the 20th to the last of the month and did a great deal of good, but they came too late for oats, which at the close of the month were estimated at a half crop.

During June the rainfall was in excess of the normal, and not well enough distributed to be of the greatest good. At the close of June there was promised a heavy yield of peaches, except in portions of the "Lower Peninsula," where growers attributed the failure to frosts, which injured the stamens in their weakest moment. The high temperature of the 15th, 16th, and 17th had a tendency to damage the wheat before it matured fully, but the rains which followed, from the 18th to the 22d, caused it to ripen nicely. The rain, however, ruined considerable cured hay, and caused the wheat of many fields to lodge badly. In places it was estimated that a loss of 5 bushels in 100 would result from this lodgment of the wheat. This trouble seemed to be confined to northern central Maryland. Tobacco planting began about the 15th, and was nearly finished by the end of the month. The wheat harvest began about the 22d, and was nearly half over by the 30th. The harvested wheat was somewhat injured by the rain of the 26th and 27th, but the general outlook at the close of the month was good for wheat, tobacco, fruit, and other crops.

The first part of July was too wet for the wheat harvest, then being completed, and much grain not housed was injured by the soaking rains, particularly the storm of the 8th. Harvesting was generally finished by the 15th. The almost continuous wet weather from the 22d to the end of July retarded farm work, injured unhoused wheat, and was damaging to all crops. Wheat thrashing was "rushed" during the fair-weather intervals. The peach harvest was begun by the 20th, and the yield bade

fair to be the greatest for several seasons. The crop was somewhat injured by the cold rains of the 28th, 29th, and 30th, but the damage was not material in most sections. The temperature during July was rather too low for the proper development of plants, but taking into consideration the heavy rains of the month, it was doubtless of greater benefit than injury.

During August the temperature and precipitation followed the normals pretty closely, and, generally, beneficial results were the consequence. Heavy rains, however, fell on the 4th and 18th, with the usual detrimental sequelæ. Considerable wheat was thrashed in a damp condition. The yield was large, in some places averaging as high as 39 bushels per acre, but the quality was perhaps a little below the average, owing to the damage by rain. Corn and tobacco did fairly well. August was essentially a peach-harvesting month, the crop, as to quantity, being almost without parallel. At the close of the month some wheat yet remained in the field unthrashed, and, on account of the wet weather, in bad condition. Corn was generally doing well; pasture was excellent, and fall plowing had commenced. The weather had not been favorable to the proper maturing of the tobacco crop, and there were some fears that the crop would be considerably injured. Vegetables and fruit, though so plenty, rotted quickly.

The peach harvest continued in September, and the crop in Maryland was one of the largest in the history of the State. The quality of the fruit was also good. The wet weather continued till the 6th, and ended on that day with one of the greatest rainfalls in the history of the station, 4 inches falling in nine and one-half hours at Baltimore. Reports from other portions of the State indicate that the excessive precipitation was general. From the 6th to the 12th the rainfall was inappreciable and the temperature above the average. Much tobacco was cut, and the late tobacco and corn matured so rapidly that injury from frosts was not probable.

At the time of finishing this report (October 1) both the corn and tobacco crops have in the main been secured, the warm sunshiny weather of the geater portion of the month having exercised a hothouse-like effect in bringing them to rapid maturity. The corn crop is said to be the largest and best in several years, and the tobacco crop about two-thirds of the average yield. The quality of the tobacco crop, however, is much above the average. The greater portion of it has been cut and housed in excellent condition.

Taken as a whole, the season now drawing to a close has been a prosperous one generally to the Maryland and Delaware agriculturist.

MICHIGAN.

From Mr. N. B. Conger, local forecast official, Weather Bureau, director of the Michigan weather service:

The crops came through the winter in very fair shape, wheat wintering very well, and at the close of March was fully up to the average for the season. There was a fair catch of clover and the crop promised well. During the fore part of April the weather was too wet for wheat, but it took the frost out of the ground in good shape and left the ground in favorable condition to receive the spring seeding. The month was cool until the last week, when the temperature was high, and the previous wet conditions placed the crops in average shape; the growth of all crops during the latter part of the month was rank. On account of the wet weather during the fore part of the month, spring seeding was delayed quite a good deal. Oats were above the ground the last week of April in the southern tier of counties.

During the first part of May the weather was too cool and dry for all crops, and fruit suffered considerably from the hard freezes of the 4th and 5th, but not as much as was at first feared. A frost-warning was sent to all parts of the State in time to save much fruit. The dry conditions of the weather at this period did much to save a greater portion of the fruit in the fruit belt of the State. The weather conditions during May were too cool and dry for crops, and consequently the crops made but slow progress; warm rains were badly needed during the month. In the northern section there was very little rainfall and the consequent effect on the hay crop was quite serious, cutting down the average fully 50 per cent. Apple trees did not bloom as full as usual this year, and the orchards were very badly spotted as to fruit-bearing trees. Corn-planting was in full blast during the middle of the month. During the last half of the month light rains occurred in the south half of the State, which tended to greatly revive the crops. A heavy frost occurred on the 17th, which cut small fruits seriously. In the southern section corn was up during the last week of May, and the cut-worms were getting in steady work on the young shoots.

The general conditions during the month of June were unfavorable to the growing crops, being too dry and cool during periods when copious warm showers were needed to create a rapid and healthy growth in the crops, yet the wheat in most sections of the State did fairly well and the yield was better than was anticipated

from the retarded growth during most of the month. No damaging frosts were reported during the month. Local showers were the rule during the month, and many sections of the State suffered considerably from the lack of sufficient moisture. In St. Clair and Sanilac counties the drought in sections was very serious to the hay crop and it was materially shortened. The southern portion of the State did not suffer so much from the drought, as local showers kept the crops in condition during the month. The continued light rainfall, and at times the cool weather, had an unfavorable effect on the crops during July, and the effect begins to show on the corn and potato crops.

Wheat cutting began in the southern section during the first week of July and was general by the middle of the month. Pastures began to suffer from the drought during the latter part of the month, but were relieved by copious showers during the fore part of August. Corn was touched by frost in different sections of the State, especially on the lowlands, but mostly in the interior counties; the damage was light. The light rainfall continued until after the middle of the month, when general rains occurred, which greatly improved the corn, potato, and bean crops, and placed the ground in excellent condition for fall seeding. Oats cutting began in the southern section during the first week of August, and was general during the last half; but some was not secured until the fore part of September, owing to the continued wet weather. The cool weather continued until the middle of the month, when a warm wave set in, which continued until nearly the end of the month, and which was the practical saving of the corn and potato crops, as the warm weather materially improved the corn crop and placed it beyond the danger of frost. The ground being in excellent condition for fall seeding, a large acreage of wheat was sown, and the crop was appearing above the ground in very promising shape at the close of the crop season.

The following estimate of the wheat crop in the State, taken from the September crop report published by the secretary of state, is compiled from reports from several hundred correspondents, and shows that the yield was very satisfactory:

"The returns from thrashings indicate that wheat in this State is yielding far better than estimated earlier in the season. On the 5th of this month, from the returns then in, the approximate yield in the State was placed at near 27,000,000 bushels. More complete returns show that the total yield will exceed this amount. It now seems certain that it will reach, and it may exceed, 28,000,000 bushels. The present uncertainty respecting the output is due to the fact that the acreage is not yet definitely determined, and also to the fact that very many farmers have not as yet thrashed only a part of their crop; hence they themselves do not know, accurately, the average yield on their own farms.

"The oat crop is better than for several years, and barley is yielding woll per acre.

"Potatoes will yield about 85 per cent of an average crop. The crop has been injured by the drought, but the recent rains will improve it. If there are no frosts until late, the very late potatoes may be materially improved.

"Winter apples will yield about 30 per cent and late peaches 82 per cent of an average crop."

MINNESOTA.

From Mr. J. H. Harmon, observer, Weather Bureau, director of the Minnesota weather service:

Owing to the heavy snows during the latter part of winter, which kept the ground well covered, the season opened most propitiously for the unusually large crop of this fall.

The rainfall for the latter part of March was in excess of the normal and the temperature normal, except in the extreme northeast portion of the State. A little seeding was reported in two or three southern counties, but the season was generally considered backward nearly two weeks.

In the early part of April seeding was commenced north and about the middle became general throughout the State, except in the lowlands and in some southeastern counties. The ground was in excellent condition to receive seed, and the last of April saw about all the wheat in, with some sprouting.

The 1st of May rye, oats, flax, and some barley were being put in the ground and winter wheat showing above in promising shape; corn was being planted south. About this time grain out of the ground was damaged by frosts and high winds, but nowhere near such a serious extent as was anticipated. Rain was much needed; light showers had fallen in the northwest, but with that exception the ground was suffering from drought.

Later in the month copious rains fell north and south and the drought was temporarily relieved, but more rain was desired. For May the temperature was in excess of the normal, but not to be compared with that of April. The precipitation further widened from the average required to insure good crops,

In early June rains occurred, which broke the drought temporarily relieved in May and improved the prospects for a large yield. Rains were again general during the last half of the month, advancing the crops materially and making June a progressive month for the crops. The heavy rainfall of the month was well distributed. Corn was retarded somewhat by the cool weather, which, however, advanced small grains and allowed them to head out well.

The continued cool weather in July lowered the condition of corn, but was exceedingly beneficial to wheat. The temperature for the month showed a daily deficiency of from 6 degrees to 8 degrees; the rainfall was also below the normal. The last of July saw harvesting in progress in the southern part of the State and haying completed.

With August harvest began north, and the warm weather which ushered in the month proved of great advantage to corn. More rain was required for buckwheat, potatoes, flax, and corn. During the month serious damage from hailstorms was reported. By the 20th harvesting was well under way in the central counties and nearly finished south. Rain set in the latter part of the month, proving of incalculable good to corn, potatoes, and late flax. On the 23d a frost occurred, doing some slight damage to uncut grain in the north and central sections, with but little hurt south except to corn in low places.

September saw harvesting nearly completed over the entire State and thrashing being pushed rapidly. Warm weather setting in early advanced corn, and the excessive hot spell from the 14th to the 25th either matured or placed the entire crop out of danger from frosts.

MISSISSIPPI.

From Mr. R. B. Fulton, observer, Weather Bureau, director of the Mississippi weather service:

In 1891 weather conditions were nearly normal, as to temperature, in January and February. Excessive rains prevailed. The weather was almost continuously cool, the occasional warm spells not lasting over a few days each. Vegetation remained quite dormant and was not affected by the five marked cold waves that came during these months.

The first half of March was characterized by marked changes in temperature. Frosts occurred over all the State about the 5th, 10th, and 15th, and in the northern part it was near the frost point during all this period. Very heavy rains prevailed, being unprecedentedly heavy in the central parts.

The cool weather and frost of the first week in March was seriously injurious to fruit and early vegetable interests, especially in the south, where vegetation had begun to bud.

Up to the 15th very little progress had been made in farm work, the ground having been continuously wet since the 1st of January.

In consequence of unfavorable weather a small planting of oats was made.

The latter half of March was favorable for planting, the ground having dried out rapidly under the increased sunshine and light rainfall. Farming operations were begun over the State, and corn-planting was well advanced in the south. The ground became too dry for the germination of corn in the southwest.

Rains occurred generally during the first week in April, sufficient for the needs of planted crops.

The cold weather on the last days of March, and especially on the 5th of April, was quite injurious to sprouted vegetation everywhere.

The market gardeners in the southern part of the State lost heavily, having been tempted to put out into the fields their tomato and other plants during the mild weather in the latter part of March. Peaches and strawberries were largely killed where they were budding, the crop being nearly ruined in the central and southern sections. Corn was killed down by the frost in the south. But little damage occurred in the northern part, where vegetation was dormant.

From the 8th to the 18th of April conditions were very favorable for spring vegetation. Sufficient showers fell, and both soil and air were in fine condition. Farming operations were pressed, and planted crops and forest growth responded with remarkably rapid development. Cotton-planting was pushed in the south, and in the north corn-planting, with preparation of land for cotton. Early vegetables were replanted in the south.

These favorable conditions continued to be improved up to the 25th of April. Generally good stands were obtained and a vigorous start was made by all staple crops. Cool, dry weather prevailed from April 25 to May 20, and was decidedly injurious. Sunshine was abundant, but cool nights and dry soil and atmosphere checked the growth of crops and caused much cotton to die after sprouting. The stand of cotton was rendered irregular almost everywhere. Corn was not permanently injured.

The last week in May afforded sufficient rain and favorable conditions nearly everywhere. Lack of moisture was again seriously felt during the first week in

June, but rains and warm cloudy weather gave an impetus to all crops between the 6th and 13th. Crops were well cultivated. Excessive rains, doing some damage, occurred between the 13th and 20th. The end of June showed good progress and rapid growth, the rainfall and sunshine having been sufficient and the temperature slightly above the normal during the latter part of the month.

July was remarkable for excessive rains, cloudiness, and low temperature. The rainfall averaged about twice the usual amount, being 6.98 inches. The temperature averaged 78.5, fully 3° below normal for the month. Rain and wind storms did considerable damage about the 7th, particularly in the south. Corn was much injured by these, and cotton was everywhere forced to make too much weed on rich lands.

On the 1st of August a fine corn crop was well assured nearly everywhere, and cotton, though late, was fruiting well. Excessive shedding did not generally follow the July rains. Probably this was prevented by the vigorous condition of the plant, and the fact that hot sunshine did not immediately follow the rains.

By the 15th of August cotton was needing more sunshine and warmer weather to force it to maturity. These conditions came from the 15th to the 22d, the warmest week of the season. The average temperature for that week was 84°, fully 4 degrees above normal. Some shedding of fruit occurred, but cotton responded generally with rapid development. This week of warm weather was succeeded by a continued period of almost unprecedentedly cool weather, the temperature averaging only 68° from the 22d to the end of the month. On four nights it was as low as 48°.

This remarkably cool weather, beginning on the 22d of August and continuing to the 12th of September, has proved disastrous to the cotton crop, decreasing by from 20 to 50 per cent the prospect of August 10. The plant, under the influence of the cool dry weather, ceased to develop new fruit. The blooms and forms fell off, many leaves were shed, rust attacked many fields, and the plant seemed to give its strength to the maturing of the lower and older bolls, which began to open very rapidly, and afford a fine quality of cotton.

Caterpillars have done but little work outside the Delta region, and loss from this cause is small compared with that from unfavorable weather. The boll-worm is still at work, but probably doing less damage on account of the prevailing dry weather. Injury from rust has been widespread and large in the uplands.

A fine crop of corn has been made, both early and late corn doing well. The former was injured by rainstorms in the south on July 7. Irish potatoes did fairly well in the spring, but the second crop is generally a failure. Peas have lately suffered much from drought. The first planted did well. Sweet potatoes have been retarded by drought, but may yet do fairly well. Sorghum was somewhat cut off by drought, especially in the south. Sugar cane has also suffered. Peaches afford a fair half crop in the north, with almost none in the south. Apples are yielding well in the north. Pears have been scarce. Fall vegetables will have small chance on account of drought. The hay crop saved is quite large. On the whole, food crops have given over an average yield. Cotton will probably fall below the average for the State at large, and much below the fine promise of the first part of August. The southeastern and northwestern parts of the State have had the most favorable conditions, and the southwestern section has had the worst.

May seems to be the most uncertain month as to rainfall and temperature, and it is an important problem to decide in what stage of advancement the cotton crop should be in order best to weather vicissitudes of that month. The season is generally long enough for corn to mature if planted any time from February 15 to July 1, and many chances may be taken on that crop as to the date of planting.

Cotton needs for its proper maturing a mean temperature of about 80° for a period of at least two months. The mean temperature in Mississippi in June was 80.5°, or 1.04° above normal; in July it was 78.7°, fully 3° below normal, and in August 78.2°, about 2° below. The seasonal temperature has thus been considerably below the needs of the crop, especially in the northern part of the State. The deficiency of temperature has been accompanied by lack of rain in August and September, and a general abundance of sunshine, excepting in July.

The cool dry weather in the latter part of August virtually ended the growing season for cotton, excepting in a few sections where local rains fell later.

MISSOURI.

From Mr. Levi Chubbuck, director of the Missouri weather service:

For the crop season of 1891 in Missouri the meteorological conditions were unusual; the precipitation was excessive every month from March to September, although very unevenly distributed, and the temperature for the months, excepting only April, was below the normal.

March was a wet, disagreeable month; while the rainfall was only one-half inch above the normal, it came in light showers, making the number of rainy days very

large. The month was unfit for farm work, and the ground plowed in February for oats was not seeded until April.

At that date some corn was also planted in the extreme southern counties. Seeding was about completed in the southeast during the second week of April and commenced in the extreme northwest, but in the remainder of the State excessive rain delayed all work.

After April 23 the conditions were favorable and farm work was pushed.

The temperature for May was 3 degrees below the normal; a cold wave passed over the State on the 6th, with general frosts and light ice, cutting melon vines and doing slight injury to fruit and garden vegetables. Light frost also general on the 11th and 27th, but no damage done.

Warm wave on the 20th and 31st, accompanied by excessive rain and general and severe hailstorms in many sections.

The first twenty days of June rain fell nearly every day, the distribution being very irregular, the greatest excess being in the central and northwest sections, while in the extreme eastern portion there was a deficiency.

The last ten days of the month were seasonable and the heavy growth of hay was everywhere secured, most of it in prime condition; the quality only of clover being slightly damaged by too rank growth.

Wheat, which had been from seeding until June 1 in a condition rarely equaled in the State, was injured by the winds and rains of the month, but the conditions for harvesting were fine in most counties and the yield per acre, determined from thrasherman's returns to date, has been above the average, of a fair quality, although the heads were not perfectly filled and some was ruined in the shock and stack in the northwest by rain. Insects were reported from several counties, but did no perceptible injury.

Oats was not a profitable crop this season, for in the southeast, the only section which produced a fair crop, the area was very limited, owing chiefly to the price of seed and fear of the grain aphis.

Corn was not benefited greatly through the month of July, for the temperature was uniformly below the normal and the rainfall continued unevenly distributed, the deficiency in the southeast amounting to a drought, which affected both corn and pastures disastrously, while in the northwest and west central the excess amounted to 3 inches.

For August the same irregularity in the precipitation continued, although very slightly above the normal for the State.

The temperature was also subject to extremes, the week ending with the 22d being the warmest of the season.

The month was not seasonable for growing crops; the very high temperature and lack of rain permanently injuring corn in the southeast counties, while the heavy rains of the last week caused a material decline in the northwest.

The weather conditions for the month of September have been a seasonable average, very favorable to maturing corn, the bulk of which is now beyond danger from frost.

Notwithstanding the continued unfavorable conditions, the season's crops already secured insure a period of prosperity unknown in Missouri for years.

NEBRASKA.

From Mr. G. D. Swezey, director of the Nebraska weather service:

The season opened very late, a snowstorm occurring early in April and snowdrifts remained on the ground as late as the middle of the month in northern Nebraska.

In the central and southern parts of the State seeding was well advanced by the middle of April, but in the northern part frost was not wholly out of the ground at this time.

There was plenty of moisture in the ground at this time, but the soil was too cold for the ready germination of seed. This was followed during the last half of April by warm wet weather, so wet indeed as to retard farming operations. The last half of May and the month of June were favorable to the growth of small grain, but detrimental to the germination and growth of corn, and which hindered the cultivation of the ground, so that corn became generally very weedy.

During the first half of July the rainfall was below normal, and the period gave good opportunity for the cultivation of the corn and the commencement of the harvesting, but was too cool for the proper growth of the corn. The last half of July was a period of heavy rainfall, with low temperature, unfavorable for the growth of corn and interfering seriously with the gathering in of the small grain.

The third week of August was a period of warm weather and abundant rainfall, which hastened the growth of the corn, which, owing to the prevailing cool weather

of the season, was at this time two or three weeks behind in average condition. This was followed by an abrupt fall in temperature, with the first frost of the season on the 23d and 24th of August, which, however, did no damage except to the tenderest vegetation.

The three weeks following were cool and dry, and the corn, which had already attained a rank growth, made hardly its normal progress.

The third week in September was very hot and dry, with south winds, which hastened the ripening of the crop, which is now out of danger from frost, with the exception of a few late pieces and in the northern counties.

NEVADA.

From Ford A. Carpenter, observer, Weather Bureau, assistant in charge State weather service:

The growing season started out warmer than usual, but with about the average precipitation. The ground being thoroughly saturated with the excessive rainfall of the preceding month, the water ran off and filled the lakes, ponds, etc., thus storing a good deal for use during the coming months. Cooler weather prevailed during April, accompanied by an abundance of rain, causing the alfalfa fields to look fresh and green. The next month, like all preceding, was chiefly characterized by long and continued rains throughout the whole State. Apple, pear, plum, and peach trees and all berries in full bloom about the 10th instant. May was reported from all portions of the State to be more favorable for the growth of all crops of grains and fruit than any other such month for thirty years. June was cloudy, cool, and, like May, very wet; but the weather turned warmer toward the latter part, making all vegetation grow wonderfully. July being normal in both precipitation and temperature, it was expected that the grain and fruit crops would exceed the yield of previous years. August was almost a perfect month for all grains, fruits, grasses, and vegetables. The wheat crop on the Truckee meadows was struck with rust and badly injured, but aside from this single instance other crops have turned out all right. The potato crop has, so far as can be learned, exceeded anything ever raised in this State. By the middle of September all grains were cut and harvested; some few late varieties of apples are yet upon the trees. Taking the growing season all in all, it has been one very satisfactory to the farmers and ranchmen.

NEW ENGLAND.

From Mr. J. Warren Smith, observer, Weather Bureau, assistant to director, New England Meteorological Society, Cambridge, Mass.:

Several heavy snowstorms occurred in New England during the month of March, 1891, and all the northern section was covered with snow at the end of the month. The maple-sugar industry was carried on to considerable extent in that section, but no work whatever was done on the land. In southern New England some plowing and gardening was done in the most favorable localities, and a few peas and early potatoes planted. The temperature and precipitation were slightly above the normal.

On April 1 the season was about ten days ahead of the average, but one of the heaviest snowstorms of the winter occurred on the 3d and prevented further work for several days. It left the ground in good condition in southern New England and farm work was rapidly pushed, the early crops being put in from seven to ten days earlier than the average. In Massachusetts and southern Vermont and New Hampshire the work on the land began about the 20th, but in the northern part of the latter States and in Maine very little had been done at the end of the month. The precipitation for the month was below the normal and the average temperature was slightly above. During the last week of the month the weather was very variable, cold windy days, with threatening weather and snow squalls, alternating with days of intense heat. The weather was generally favorable for farm work, but too cold to put seed into the ground. Heavy frosts occurred on the 29th and 30th, but little damage was done. Rain was much needed at the end of the month, the dry weather continuing over the greater part of New England until May 16. The weather was very cool during the first week in May, and that, coupled with the dryness, made the ground very unfavorable for seed and very little was put into the ground in any section. Heavy frosts occurred on the 5th and 6th, doing great damage to strawberries and to other crops that were above the ground. It was somewhat warmer in the second week in May, and at the end of that time the greater part of the early grains were sown and potato-planting was well under way in the south and well begun in the north, although seeds germinated slowly in the dry soil. A hard freeze

occurred over New England on the morning of the 19th, again doing much damage to strawberries and to fruit and all vegetation. All crops that were above ground, especially in the northern States, were cut down and grass was somewhat injured. Considerable rain fell on the 16th, but the ground was quite dry during the last of the month, the total precipitation being over 1¼ inches below the normal. The mean temperature was over 1 degree below. Planting was not generally completed in the northern States until nearly the end of May—several days later than the average—and all crops started slowly.

During the first week in June heavy rains fell over the greater part of New England, but generally cool weather prevailed, with frosts on the 5th and 6th doing some damage. Dry weather, with steadily increasing heat, prevailed from the 5th to the 16th, accompanied by strong drying winds and much sunshine, and on the 15th and 16th a degree of heat was felt which is seldom ever experienced so early in the season. The effect was very unfavorable on all crops, excepting perhaps corn and tobacco. Grass was much injured and cutting was begun immediately, in the south. Heavy rains fell on the 16th-19th and on the 22d, and more favorable weather prevailed during the last half of the month, although a little too cool. Crops grew well, and grass on lowlands and in the northern States was much improved. Both temperature and precipitation were below the normal during the month.

Much hay was cut in southern New England during the last of June and the first week in July, many farmers completing the harvest. The hay was of excellent quality, but only about 75 per cent of an average crop. Hay-cutting was begun in southern Vermont, New Hampshire, and Maine during the first week of July, and in the northern part of those States it was not general until the second week. The precipitation for the month of July was about the normal and was well distributed. The maximum and minimum temperatures were both considerably lower than is usually registered during the month and the mean for the month was over 3 degrees below the normal. At New Bedford, Mass., the mean temperature was the lowest since 1816. Crops generally grew quite well, but more warmth and sunshine were needed for corn and similar crops.

The mean temperature during August was slightly above the normal, with no extreme ranges. The precipitation was below the normal and a slight drought was experienced over most of southern New England, especially during the first half of the month. In southeastern Massachusetts and Rhode Island and in the southern Merrimack valley dry weather prevailed until the first week in September, but in other places a sufficient quantity of water fell after July 16, and all crops were favorably affected. Corn and grain made a luxuriant growth and will yield large crops. The former was ready for harvest on the 12th (September) and in the south cutting had begun. In the northern States a week or two more of warm weather and sunshine are needed to perfect the growth. The ears have set well and are well filled. Grain was mostly cut before the middle of August, and where thrashed has yielded much above the average. Haying was mostly completed in the northern States by August 25, and more than an average crop was secured. The tobacco harvest was begun during the last part of July, and was generally completed by September 1. A large crop was secured, and of excellent quality. Potatoes were affected by disease during the last of August, but not seriously.

Heavy rains fell on August 28, and on September 8 and 9, doing some damage to crops, but putting the ground in most excellent condition for fall plowing and seeding. Favorable weather was experienced during the first of September for the ripening of crops and harvesting. A large part of the cranberry crop was picked during the week ending September 12. The crop is slightly below the average.

Cambridge, Mass., September 16, 1891.

NEW JERSEY.

From Mr. E. W. McGann, observer, weather bureau, director of the New Jersey weather service, New Brunswick:

The State of New Jersey is in area 7,526 square miles, or 5,263,641 acres. Its climate partakes of the continental type, and is marked by extreme features, but softened to a degree by its close proximity to the ocean. That portion of the State south of Trenton, its capital, is known as southern New Jersey, and is particularly adapted to agricultural uses. The soil is a sandy loam, free from stones, and is well adapted for the raising of all varieties of early truck. The chief crops are potatoes, both round and sweet, sweet and field corn, melons of all kinds, tomatoes, squash, and orchard fruits (peaches and pears). Plowing in this section was possible during a portion of every month during the year, but during the early spring months both it and the planting of early truck were greatly retarded, except on very high ground, by the excessive rains.

The weather conditions which prevailed during the month of April were more favorable, and plowing and planting were pushed rapidly along. All crops did well until the cold spell of May, when severe frosts on the mornings of the 4th, 5th, and 6th did considerable damage to early potatoes and strawberries along the seacoast. The absence of rain now began to be seriously felt and all crops were suffering for the want of it, until near the close of the month, when copious showers relieved and greatly benefited all vegetation. Fruits were then in a most promising condition. The cool nights which prevailed during the first half of June retarded all growth, especially corn, and the maturing of the earlier varieties of strawberries; but the warmer weather which followed helped along all crops. Haying was commenced about the 15th of June and the yield was not more than one-half of the average yield, owing to the frequent droughts during the spring months. At the close of June all crops in this section were in a promising condition, as the heavy rains which fell during the preceding week revived all growth.

Small fruits were in marketable condition on the 20th of July, and the frequent light showers which fell during the picking time were of great benefit in putting this crop to market in good condition. At the close of July the melon crop was about ten days late, owing to cool nights and a deficiency of rainfall.

The early part of the month of August was unfavorable to all crops, except orchard fruits. Cloudy and wet weather prevailed, which was injurious to tomatoes, potatoes, and sweet and field corn, these crops needing more warm sunshine. These unfavorable conditions continued almost during the whole month, and injuriously affected the early peach and truck crops as well as tomatoes, the latter cracking badly on the vines; but the warm and bright sunshiny weather which prevailed during the entire month of September brought all crops rapidly on to maturity to such an extent that the picking of tomatoes, the digging of potatoes, and the cutting of corn was well under way at the close of this month.

The central portion of the State differs very materially from the southern as to climate, soil, and the crops produced. The soil is largely red shale, loam, or clay, and the principal crops are winter grain (wheat and rye), corn, oats, late potatoes, a little garden truck, and orchard fruits (principally apples and peaches). The wheat and rye gave indications early in the spring that no serious damage was done during the winter months by the frequent freezing and thawing. Plowing was commenced early in March, but owing to the reavy rains very little progress was made with this work until the last three days of the month.

During April the planting of potatoes, corn, and oats was quite general, and the weather conditions being favorable, satisfactory progress was made. The growth of all crops, however, was seriously checked by the dry weather and brisk winds which followed the planting and sowing. In many sections the replanting of corn and potatoes was necessary. The severe frosts which occurred on the mornings of the 4th, 5th, and 6th did great damage to early potatoes, which were well above ground, and also to the early varieties of strawberries and tender vegetables. The orchard fruits, which were in full bloom at this time, escaped. The close of May saw no change in the existing conditions, the dry spell still continuing and the cool nights which prevailed making the conditions even more unfavorable to the general growth of all field and garden crops. About the middle of June the condition of all crops was not highly encouraging. Although there was an increased acreage of corn and potatoes planted over the preceding year, the drought and late frosts had made corn come up poorly and necessitated much replanting. Fruits of all kinds continued in a most promising condition. The harvesting of wheat, rye, and hay commenced about June 24 and was completed by July 3, having been favored by excellent conditions.

During the months of July and August rains were more frequent and, aided by the warmer weather, corn made a remarkable growth, as did all field crops. Early fruits matured well and were marketable by July 24. The high temperature which prevailed during the last week of August and during all of September was most beneficial to all crops, especially corn. The cutting of this crop commenced about September 15 and was quite general on the 22d. The digging of potatoes generally took place from September 1 to 3 and continued until the crop was all housed. Fall plowing in this section was delayed by reason of the dry condition of the ground, owing to the absence of rain. In the northern section of the State the principal crops raised are wheat, rye, oats, and orchard fruits (principally apples and peaches) and a little late truck. Dairy farming, however, is the principal feature and is given especial attention.

In this section during the early spring months all farm work was well advanced, and by the middle of May wheat and rye obtained a most promising stand; but grass, which was so promising a few weeks earlier in the season, was suffering from want of moisture. The heavy frosts on the mornings of May 4, 5, and 6 did considerable injury to early fruits and vegetables. The frequent light showers during the last week of May greatly stimulated all growth. At this time oats were very backward,

owing to the cool dry weather, and grass was too far gone to be benefited by the rains. The yield of this crop was far below the average and the lightest harvested for a number of years. The warm nights which prevailed during the middle of June caused all crops to make a rapid growth and wheat and rye to ripen rapidly. The harvesting of wheat, rye, and oats commenced during the last week of June, and by July 5 these crops were safely housed in better condition than for a number of years. The abundant rains which fell during July and August greatly benefited all crops, especially grass, and the meadows again afforded ample pasturage for the cattle. The weather conditions which prevailed during the month of September were all that could be desired for growth and maturing of the late crops. The cutting of corn was commenced about the middle of the month, as also the sowing of winter wheat and rye, but the latter was retarded somewhat by the very dry weather which prevailed during this month.

At the time of closing this report (October 4), the winter grain which was sown during the early portion of September is growing well and has a very promising appearance.

NEW YORK.

From Prof. E. A. Fuertes, of the New York meteorological bureau:

The crops of New York wintered well, and the unusually cool and cloudy weather, while retarding general farm produce, checked the development of fruit buds until the danger of serious injury from frost had passed. By the middle of March, notwithstanding the continued cold and wet weather, the prospects for fruits and grains were good. Plowing had become general in the southern portions of the State, but owing to excessive moisture the soil was in bad condition for working, while north of the Mohawk Valley this work had scarcely commenced. During the last week of March potatoes had been planted and gardening was well advanced on Long Island. The maple-sugar industry was well under way in the southern counties, while in the most northern section little sap had as yet been collected.

During the first part of April abnormally cold weather and heavy snowstorms caused a general suspension of plowing, seeding, and other farm work. Although excessively cold weather prevailed, the deep snows of the 2d, 3d, and 4th protected grains from damage, while fruit buds were not sufficiently developed to sustain serious injury. In the western counties, generally, grass and grains were slightly damaged by the alternate thawing and freezing of the ground, causing upheaval; but over the greater part of the State reports were still favorable concerning these products. The production of maple sugar had begun in the northernmost counties, and large amounts were being made. The middle of the month was characterized by unusually warm weather, with about the average rainfall. Grasses and grains had a vigorous growth, spring sown oats were above the ground in the warm southern valleys, peach trees were in bloom in the southern Hudson Valley, and in many localities the season was stated to be from one to three weeks in advance of the average year. Plowing was being pushed rapidly forward and the soil fitted for corn in the southern sections, while in the northern counties the warm weather had brought the frost out of the ground; but in general, the soil was too wet for working. In the hop regions of the north, hops, which appeared to have wintered well, were uncovered and rooted. Fruit trees were heavily budded, and the prospects for fruit and berries were unusually favorable. Some tobacco was being planted in Oswego County. During the latter part of April the temperature was below the normal, and this, added to the general deficiency of rainfall, somewhat checked the growth of vegetation; but, owing to the very favorable preceding weather, the season was still well advanced. Soil hitherto too wet for working was plowed, and much spring sowing was done.

During the first two weeks of May the continued dry and unusually cool weather retarded vegetation, and crops dropped back to their average seasonal growth. Trees were in full leaf and fruits had blossomed by the 3d and 4th in all sections except the colder parts of the northern counties. On the 5th and 6th severe frosts occurred all over the State, the minimum temperatures ranging from 1 degree to 5 degrees below the freezing point; but owing to the dryness of the atmosphere and the prevailing cloudiness little damage was done excepting on portions of the western highlands. During the middle of the month copious rains in the eastern sections of the State revived the parched vegetation, but in the western part the ground had become too dry almost for cultivation, and crops, especially grass, were supposed to have sustained serious and permanent injury. The germination of corn and seeds recently sown was greatly delayed. Many vineyards and fruit trees were reported ruined by the frosts of the 16th and 17th. General but insufficient rains fell on the 22d and 26th, and this, with the continued cold weather, kept the crops back. Severe frosts occurred on the 26th and 27th, which did considerable damage in the northern

counties. Many early potatoes and strawberries and other tender plants were reported killed.

During the first part of June crops over the State were very much in need of rain. The hay crop was generally estimated at a half or less; and winter wheat, while in better condition than other grains, was becoming discolored and thin. Many farmers plowed up their oats and planted buckwheat; and corn, while doing well in the eastern part of the State, was elsewhere replanted to a considerable extent. Tree fruits in general promised a fine crop, although less than an average yield of apples was expected. Cherries, with strawberries and other small fruits, were reported to have suffered severely by the drought. Rains on the 11th, 16th, and 17th, and a good general rain on the 18th, broke the drought, and fruits and cereals were greatly revived; but the hay crop was generally too far advanced to receive much benefit. Haying began about this time in scattered sections, with prospects of one-half to three-fourths of an average yield; while oats and other spring grains, although growing well, were generally thin, owing to the fact that much of the seed did not sprout. Corn and potatoes, although backward, were making rapid growth, and hops were in fine condition in the northern counties. At the close of June the crops were doing well, although needing rain. Oats, corn, late barley, and the condition of pastures had greatly improved. During the last week haying was begun in the southeastern sections. The rye harvest had also commenced in the lower Hudson Valley, with prospects for an average yield. The temperature and rainfall were below the normal, and a drought prevailed over the eastern part of the State, which seriously injured pastures and potatoes. Hudson Valley grapes, however, were bearing well.

Unusually cool, cloudy weather, with normal rainfall, obtained during the first part of July, which somewhat retarded the growth of corn, potatoes, and garden truck; but the prospects for grass had greatly improved. During the first week wheat, rye, and barley harvesting began in the Hudson Valley. Peaches, pears, plums, and cherries were in fine condition, and an average yield of apples was expected. By the middle of the month considerable portions of the hay, wheat, and rye crops were secured in excellent condition, but in the northern portions this work had scarcely begun. Wheat and rye were of a good color and well filled, and the hay was of an excellent quality. Oats and potatoes were well advanced and in fine condition; corn, although growing well, was still backward. A drought prevailed in the southeastern section, which seriously damaged early potatoes and caused increased injury to crops that had not recovered from the prolonged lack of rain in May and June. Tree fruits were in good condition. Showers during the latter part of June delayed the harvesting. The oat harvest was well advanced in the southern Hudson Valley. Corn was still retarded by the cool nights, but promised a good yield. Apples were unusually sound, although the yield was not large. Pears and peaches continued in good condition, although the peaches were undersized, which fact was attributed by some observers to the excessive yield. In a few peach orchards in Orleans County the "yellows" was noticed. Although the potato blight was reported in a few sections, the crop in general was in excellent condition, especially the late planting.

During the beginning of August heavy local rains occurred and the temperature was considerably below the normal. The wheat and rye harvests were completed, wheat giving more than an average yield and the rye less. The oat harvest became well advanced, with large yield of grain and straw. In general, the crop was free from rust. Buckwheat blossomed and was growing finely. Tobacco, while backward in some localities, promised well. Pears, peaches, and plums were an abundant yield, although the peach "yellows" showed a tendency to spread. The rainfall during the middle of August was very unevenly distributed, and the temperature was above the normal. In general, the ground was in good condition for plowing, excepting in the lower Hudson Valley, where continued drought rendered the soil unfit for working and greatly damaged such products as had not matured. More than the usual amount of bright weather prevailed over the State, however, giving an impetus to late crops as well as checking the potato rot and blight, which had developed to a small extent in various localities. The harvesting of oats progressed rapidly, the yield being much above the average in quantity and quality. Corn grew well and reached an average maturity, excepting in the cool northern sections or where retarded by heavy local rains. Tobacco was growing finely; hops were in good condition in Franklin County, although elsewhere the outlook was not so favorable as a short time previous, principally on account of the ravages of the hop aphis. The temperature for the last part of the month was about normal, while severe local storms distributed the rainfall very unevenly over the State. Pastures and meadows were in fine condition. The ground was excellent for working, and a considerable acreage of wheat and oats had been sown by the end of the month. The oat harvest was not quite completed, and some grain had been slightly damaged by moisture. Corn was still backward. The potato crop was not as promising at the beginning of September as it had previously been. The blight, although not

existing generally, was locally reported from many sections. The outlook for buckwheat was very favorable, and a portion of the crop had been harvested in Chautauqua County. In Franklin County hop-picking began on the 1st of September. The hops were found to be somewhat damaged by moisture. The tobacco harvest began during the first week of September, with prospects for a large yield, of excellent quality.

The temperature and rainfall for the first part of September were about normal and very favorable for vegetation, especially grass, buckwheat, and fruits. The ground remained in excellent condition and fall seeding progressed rapidly and was well advanced. The sowing of wheat and rye was nearly completed in many portions of the State. The potato blight still continued in some few sections, but the tubers were generally in a sound condition and a large crop was being marketed. Owing to the cool nights, corn was still backward, excepting in a few localities, but the harvesting of the crop was expected to be general by the 14th in the Hudson Valley. Buckwheat harvest was well under way by the 10th, and the crop promised well. Owing to the prevailing cloudy and wet weather in the northern part of the State, considerable quantities of oats and other grains remained still in shock on the 9th. Franklin County hops, on account of excessive moisture, are estimated to be below the average yield. The quantity of grapes is below the average, but the quality of such as have ripened is reported very good. Tree fruits in general are abundant, and apples, although the yield is not as great as usual, more than make up for the deficiency by their fine quality and sound condition. Corn is reported as well filled, and an average crop is expected.

NORTH CAROLINA.

From Dr. H. B. Battle, director North Carolina weather service:

Average dates of planting and harvesting of crops:
- Preparation of soil generally completed by end of March.
- Cotton planted April 1 to April 30; harvested August to January.
- Tobacco transplanted April 1 to May 10; harvested July to October.
- Corn planted about April 1; harvested in September.
- Wheat planted October 10; harvested June 1. Oats and rye planted September 10; harvested June 15.

Dates of planting and harvesting of crops in 1891:
- Preparation of soil begun April 1; done very hastily.
- Cotton planted April 15 to May 22; picking, not general, September 15.
- Tobacco transplanted during May; curing commenced August 28.
- Corn planted early in April; harvested average date.
- Harvesting wheat and rye progressing June 19; planting September 10.

Normal mean temperature, and rainfall and departures for 1891.

Months.	Temperature.	Departure, 1891.	Rainfall.	Departure, 1891.
January	41.5	−0.2	4.64	+0.20
February	44.7	+3.2	4.10	+1.50
March	48.8	−3.5	4.83	+2.50
April	57.9	+1.2	4.00	−1.78
May	67.5	−3.3	4.10	+1.26
June	74.9	+0.5	4.64	−1.25
July	78.6	−4.1	5.24	+1.50
August	76.4	−0.7	6.09	+1.91
September	71.1	....	5.20	....
October	60.7	....	4.17	....

The weather crop conditions during the season of 1891 have been unfavorable from the beginning in the State of North Carolina. Owing to the continued cloudy weather and excessive rains during the first three months of the year the usual preparation of the soil, which begins early in March, was delayed fully three weeks. March was the coldest and wettest month, with a departure from the normal of −3.5°, and an excess in precipitation of 2.50 inches. The soil became soaked, roads were so muddy as to be nearly impassable, and outdoor work was impossible. At the beginning of April the "rainy season" suddenly ended with a cold snap, sending the temperature below freezing on the 5th, with heavy frost. Drought prevailed during the latter part of April and the first half of May, causing the soil to become rapidly dry and hard.

Planting was done chiefly during April and early part of May, and was done too hastily, without proper preparation of the soil, resulting from the start in a poor

stand of the chief crops, especially cotton. The stand was further injured by the late killing frosts of May 5, 6, and 7, which greatly damaged truck crops and injured cotton in many places so as to necessitate replanting, some of which was done as late as May 22. Fruit generally escaped serious injury. The transplanting of tobacco, which generally begins April 1, was commenced a month later this year. The weather conditions during May were unfavorable because of the drought during the early part, broken about the 12th, and on account of the decided deficiency in temperature, the departure from the normal being $-3.3°$. This was the chief cause of the subsequent poor and late condition of the cotton crop.

June was the most favorable month of the season, being slightly in excess in temperature and deficient in rainfall. Crops grew rapidly and farmers were enabled to cultivate and destroy weeds and grass, which had made unusual headway. The favorable conditions continued until the 10th of July, at which date cotton was blooming freely and crops were cleared of grass and well cultivated. But the remainder of July was unusually cold and wet, making it the coldest July for the past twenty years. The deficiency in temperature for the State was 4°, with an excess in precipitation of 1.50 inches. The condition of all crops except corn rapidly deteriorated, especially cotton, the growth of which was delayed and blooming stopped. The first three weeks of August were favorable for all crops, but excessive rains fell again during the latter part. September was drier, with cool nights, which were decidedly unfavorable.

The condition of crops during the latter part of the season is as follows:

Cotton is from three to four weeks late, bad stand, very weedy, but not fruiting well; is shedding upper squares and is suffering materially from rust. An early frost would do very great damage, but with very late fall a conservative estimate would not place the yield higher than 70 per cent of a full crop. Cotton is opening very slowly and picking is progressing at but few places, while at this time last year the greater part of the unusually large crop had been picked and marketed.

Tobacco is being cured rapidly, but the damage by excessive rains during July and the latter part of August is now seen to have been considerable. Curings are too frequently poor both in color and quality, but the yield will be good.

Corn was in excellent condition throughout the year, and a full crop gathered. The uniformly good condition of corn as compared with cotton, even in unfavorable years, should serve as a warning to farmers to place more dependence on food crops and less on cotton, which seems always the first to suffer from the effects of bad weather.

Trucking was very successful in the southeastern part of the State. The yield of fruit is excellent and abundant. The yield of grain and minor crops has been somewhat below the average.

A special characteristic of the season was the unusual number of destructive hailstorms occurring during May, June, and July, which have inflicted thousands of dollars damage to crops in this State during the season.

The crop season of 1890 was so excellent, the yield of the staple crops (except fruit, which was a failure) being the largest obtained for many years, that the following comparison of the departures during the first half of the years 1890 and 1891 is instructive:

Months.	Departure in temperature, 1890.	Departure in rainfall, 1890.	Departure in temperature, 1891.	Departure in precipitation, 1891.
January	+9.0	—3.21	—0.2	+0.20
February	+6.9	+0.10	+3.2	+1.50
March	—0.8	—1.43	—3.5	+2.50
April	+0.8	—1.25	+1.2	—1.78
May	+0.0	+0.69	—3.3	+1.26
June	+2.7	—1.81	+0.5	—1.25
Total	+18.6	—6.91	—2.1	+2.43

OREGON.

From Mr. B. S. Pague, observer, Weather Bureau, assistant director of the Oregon weather service:

Farming operations in Oregon are almost continuous. The harvest of 1890 was finished, and immediately plowing and seeding were begun. The fall plowing and seeding depends upon the commencement of the autumn rains. The almost rainless period from June 20 to September 20 allows the earth to become very dry, and it is not until the rains begin that extensive plowing can be prosecuted. Hence favorable climatic conditions are of paramount importance. The period from July 1, 1890, to January 1, 1891, was unusually dry, the precipitation in those six months

being from 15 to 70 per cent below the normal amount. The temperature was about 2 degrees above the normal. During December and January much of the land was prepared for seed. Almost uninterrupted outdoor work was done during January. Spring was apparent during the month, buds swelled, leaves broke forth, and an open winter seemed imminent. There was an absence of frost in the ground up to the 1st of February. February was cold and wet. In western Oregon the ground was thoroughly saturated with moisture; in eastern Oregon snow covered the ground. The backward conditions commenced February 1 and continued up to March 21, when warmer and drier weather prevailed. There was little farm work done during the month of March. In western Oregon the soil was too wet, except on the uplands; in eastern Oregon the snow was melting; by close of month the snow was gone, but the soil was too wet to be worked. Up to April 1 there was little spring seeding done. The winter wheat was, however, in excellent condition; the mildness of the winter prevented any freezing out; it had a good color, and was well rooted and well stooled. April opened cool, with freezing temperature and frost, and closed with springlike temperature and weather. The April night temperature was higher than usual. There were no warm days; only one maximum was reported above 80°. During April spring seeding progressed very well, especially in southern and parts of eastern Oregon, in Umatilla and Morrow counties particularly. The cool weather checked rapid growth and allowed vegetation to gather root, strength, and vigor. Toward the close of April winter wheat had good growth. Oats were healthy and had an equal growth with wheat. By April 20 fruit trees were blooming and leafing; hops were above the ground and in a very thriving condition; sheep shearing was in progress and the best clip for years was being secured. Owing to the mild winter, stock wintered remarkably well and the range grass was very good. There were frosts in March and April which at the time were not considered damaging, yet during May it was found that the fruit was considerably injured by them, not sufficiently injurious, however, to make a marked shortage in the total yield of fruit, for fruit trees bear so heavily that unless frosts prune out the superfluous fruit it must be done by hand, otherwise the fruit trees would bear themselves out or break down. Seeding continued during April, first on the uplands; then, as the soil gradually dried out, seeding was done on lower land. By May 10 seeding was practically over and the weather conditions were very favorable to the growth of all crops. The entire spring was backward; April weather was favorable to the life and vigor of vegetation, May to the growth and advancement, up to the 23d, 24th, 25th, and 26th, when hot dry winds prevailed along the upper Columbia River basin, doing considerable damage to cereals. During June cool, partly cloudy weather, with general and frequent rains, prevailed. There was an absence of any injurious climatic conditions and the presence of all favorable ones. The ripening period was delayed, but the certainty of fine crops improved each day. Haying was in progress during the month, and never before were there such hay crops secured. Strawberries and cherries yielded well, although both were injured by the rain. Hops thrived, and the hop-louse made its appearance. The weather conditions kept the codling-moth and kindred insects in embryo. July was favorable to the ripening of cereals, fruit, etc. There were no injurious conditions except an extremely hot period from the 22d to the 25th. In Wasco and Sherman counties the grain was somewhat injured; in other sections it was too far advanced to be injured, considerable fall wheat having been cut. During August harvesting was in fine operation. Rains on the 4th, 5th, and 6th delayed harvesting, but did no damage. Harvesting continues on September 12, and will continue until about October 1, when practically all the grain will have been thrashed.

To summarize, it might be said the dry autumn of 1890 delayed fall plowing and seeding, the warmth of December and January advanced vegetation, the cold and wet of February and March delayed spring operations and advancement of vegetation. April, May, and June were very favorable to the growth of vegetation, July and August to the ripening and harvesting of products.

Frequently in June the weather becomes very dry and a hot period comes along, which does great damage to the grain, drying it up, shriveling the berry, etc. This year the only injurious climatic condition was the hot wind in the latter part of May, which did slight damage in the upper Columbia River basin. The June rains, however, repaired about all the damage that was done.

The harvest of all cereals and fruit in Oregon this year was never better. The wool clip was large and most successful. Stock wintered well, the loss was practically nothing, and they were in prime condition for sale in May and June. Hops bore well, but the hop-louse did damage. Corn never yielded so well. Melons were plentiful and of immense size. Garden truck was late in developing, but all gardens were successful. Potatoes are so plentiful that many acres will not be dug, as they won't pay for the digging. Good prices prevail, debts and mortgages are being paid off, and the Oregon farmer is happy and prosperous over the successful harvest of 1891.

OHIO.

From Mr. Charles M. Strong, observer, Weather Bureau, secretary of the Ohio meteorological bureau:

Excessive rainfall during the month of March and deficiency in temperature during the first half of April prevented farming operations on any large scale from taking place.

During the latter part of April and the first few days in May farming operations were in general progress in all sections of the State, and advanced rapidly under favorable auspices, although the ground being rather hard made plowing difficult and delayed the work.

The temperature and sunshine, both above the normal, favored plowing and the development of wheat and grass, which grew rapidly. The rainfall was deficient and was badly needed to soften the ground. From the 2d to the 9th of May the temperature was much below the normal; killing frosts, with ice forming, being reported generally from all sections of the State on the mornings of the 5th, 6th, and 7th. The wheat plant was badly touched in localities in the northeast section. Tender plants and fruit were seriously injured north of Columbus, and grape shoots were badly nipped in many localities south. A peculiar haziness and dryness of the atmosphere contributed largely toward preventing serious effects from frost south of the center of the State. The drought that began during the month of April continued until the 19th in the northern and middle sections, when copious showers fell, reviving the vegetation, which was begining to suffer seriously. Despite the drought the wheat continued to improve under the influence of the dry cool weather to the 17th, when another killing frost injured it somewhat on low grounds in some localities. This frost also killed garden vegetables, fruit, potato vines, and corn in the northern and middle sections. The effects of the frost on fruit were noticed in the latter part of the month, in the general falling off from trees. The month closed with excessive cloudiness and lack of warmth, but was beneficial on account of continued excess in rainfall, which further relieved the droughty conditions and placed ground in better condition for working.

During the first of June excess of rainfall and alternate sunshine and cloudiness produced excellent growing weather. Cereals were doing well, although the corn was retarded in growth by the cool nights. Increased warmth, with deficiency in cloudiness and rainfall, formed very favorable conditions throughout the balance of the month, and were evidenced in the rapid development of all growing crops, especially corn, potatoes, and tobacco, and the maturing of the wheat, which was being harvested in the middle and southern sections at the end of the month. The rapid development, with accompanying high temperatures, proved injurious in only one thing, that is, in the rapid growth of weeds in the corn and baking hard of the ground.

During the month of July the temperature was considerably below the normal, but injurious effects that would naturally result from this condition were overcome in a large degree by deficient cloudiness and opportune rainfalls. As a whole, conditions continued favorable, and the development of all crops, except the corn, which was hindered by the cool nights, were in proportion. In the northwest portion of the State droughty conditions prevailed during the latter part of the month; also, grasshoppers proved very destructive to oats and pasturage. At the end of July the wheat was generally secured, oats were ready for harvesting, and fall plowing was ready to begin.

During the first week in August the deficiency in temperature, with excessive cloudiness, rendered conditions unfavorable for corn and potatoes. The farmers of the northwest section were cutting their oats to save them from the grasshoppers. Fall plowing was also commenced. During the second and third weeks corn, potatoes, and pastures were affected unfavorably by continued dry conditions, but the oat harvesting was facilitated. The drought was especially severe in the northwest portion of the State. During the week ending the 29th the drought was generally relieved by copious showers; corn, potatoes, and pasturage were revived, and fall pasturage saved. Fall plowing continued during the month under generally favorable conditions, the only difficulty encountered being dryness of soil.

Deficiency in temperature, excessive cloudiness, with only normal rainfall, rendered conditions unfavorable at the commencement of September, but this was relieved by the second week by return to more seasonable conditions, followed the third week by summer heat and dryness, which, at the present writing, has placed all crops in a secure state and matured the corn, tobacco, and potatoes.

The fall plowing is about finished, also wheat seeding, with largely increased acreage.

Fall pastures are again suffering from droughty conditions.

Periods of drought, wet weather, or normal conditions:
- March 1 to 10, normal rainfall.
- March 10 to 20, excess in rainfall.
- March 20 to April 9, normal rainfall.
- April 9 to May 19, deficient rainfall.
- May 19 to June 8, excess in rainfall.
- June 8 to 28, deficient rainfall.
- June 28 to July 8, excess in rainfall.
- July 8 to 18, normal rainfall.
- July 18 to 28, deficient rainfall.
- July 28 to Aug. 7, excessive rainfall.
- Aug. 7 to 27, normal rainfall.
- Aug. 27 to Sept. 12, deficient rainfall.

Cool and warm spells:
- March 1 to 30, warm.
- March 30 to April 9, cool.
- April 9 to 29, warm.
- April 29 to June 8, cool.
- June 8 to 28, warm.
- June 28 to Aug. 7, cool.
- Aug. 7 to 27, warm.
- Aug. 27 to Sept. 12, cool.

PENNSYLVANIA.

From Mr. L. M. Dey, observer, through Mr. Ball, assistant observer:

A State large as Pennsylvania must necessarily be divided into several areas, in each of which general farming operations—the planting and raising of crops and their final harvest—occur at different periods of the year. Local farming operations depend upon both the latitude and the altitude of a given place, so that we find farm work either more advanced or behindhand according to location, whether in a higher or lower latitude, in the valley or upon the mountain side. Spring farm work properly begins with plowing for spring wheat, oats, and early potatoes. The date of commencement depends upon the character of the past winter and the condition of the ground during March and April. As soon as the ground thaws sufficiently the plow is put in and the work occupies the greater part of March and April. The plowing season of 1891 in Pennsylvania was unfavorable.

In many places the ground was hard and dry, and farm work and plant growth were backward. Corn-planting usually extends from about May 1 to June 10. This season the planting was late and slow. Much of the early planting failed to germinate, owing to the insufficient moisture. Frosts and some freezing weather occurred during the last week in April, but only slightly damaged fruit trees and tender plants. The trees were heavily laden with bloom, and some declared that the frost was beneficial, as it caused many of the blooms to fall, thus relieving the weighted trees.

From May 1 to 15 plowing for corn was still in progress in the northern counties, while in the southern the planting was well advanced and some of the corn was above ground. The season was still backward. Cold dry weather continued, yet little damage was done to wheat, grass, and fruit trees. Considering the unseasonable weather, the fine appearance of vegetation and growing crops at this time was remarkable. After May 15 the outlook grew serious, the drought continued, and all crops were suffering. Corn planting was delayed and wheat and grass showed the lack of moisture. The temperature at this time was nearly normal, which was exceedingly fortunate.

By June 1 crop planting, except tobacco, was nearly over. Weather still unfavorable, and but little rain had fallen. During the week ending May 29 general rains had fallen, and these in many sections saved the crops from serious injury. Cool weather continued, yet, notwithstanding all, the condition of the crops was encouraging.

A hot spell occurred from the 8th to the 17th of June, and the crops advanced rapidly. The warm weather and generous rains lent renewed energy to plant life. Corn especially improved wonderfully, and correspondents stated that wheat never looked better than at that time. Enormous crops of tobacco and potatoes were planted, the warm showery weather being especially favorable for tobacco planting.

By July 1 haying had commenced and tobacco had been about all planted. All crops were in fine condition and the weather propitious. Wheat harvest began about July 3 and was soon in full blast. Rarely before has such an enormous yield of wheat been seen in Pennsylvania. Everywhere farmers were rejoicing at the luxuriant fields of waving grain. Other crops were also in fine condition. The

weather was cool and retarded the growth of corn, but the outlook for a large crop was very promising.

Hailstorms on July 3 did some damage to corn, tobacco, and fruit in the central portions of the State. Thus far the season had been without destructive storms of any kind.

Wheat harvest was nearly over by July 20, and still greater satisfaction was expressed at the prospects of a splendid yield.

A protracted cool spell occurred during the whole of July and the early part of August. On three days only did the temperature rise above the normal. No serious damage resulted, other than to delay the growth of corn. From August 12 to about the 25th the weather was generally warm and sultry. In the extreme northeast section the drought remained unbroken and the crops suffered greatly. Wells, springs, and small streams were dry, and it seemed that the season would be disastrous. Copious rains fell during the latter part of August and greatly revived vegetation.

The week ending August 28 was characterized by destructive and terrific rain floods in the interior counties of the State east of the Allegheny Mountains, and especially in the Schuylkill and Lebanon valleys. In many places the rain was the heaviest ever recorded, but fortunately the crops on the whole were too far advanced to be seriously injured. The period of wet weather continued until September 7. Since then the days have generally been fair and cool, affording excellent opportunity for farm work. Corn needs more sunshine and warmth to mature it before frost. Preparations are making and fall seeding will begin properly about the middle of September. Farmers are rapidly pushing the cutting of tobacco, the cool weather causing them to fear the approach of frost.

On the whole the year has been singularly prosperous, and well illustrates the proverb, "A bad beginning makes a good ending." The early season was unfavorable. Cool weather and dry soil retarded farm work and the growth of crops. Notwithstanding all, the outlook was at all times favorable. A brief period of drought darkened the bright horizon, but generous rains and plenty of sunshine dispelled the gloom. The extreme northeast section, it is true, suffered a protracted drought, but rain came in time to save most of the crops and the yield was very fair.

In conclusion, it can be said that few years within the memory of man have yielded more abundant harvest, few have given more pleasant weather for farm work, and few have given less cause for complaint of floods, droughts, insects, or the many other evils so well known to agriculturists.

SOUTH CAROLINA.

From Mr. A. P. Butler, observer, Weather Bureau, at Columbia, director of State weather service:

The general farming operations began about the 1st of March, but were attended with but little success. The excessive rains prevented the proper preparation of the soil and greatly retarded the planting of the corn crop, so that at least half of April was consumed before the farmers could prepare any portion of the lands for the cotton crop. About that time the rains ceased and the soil became so hard that it was impossible to plow and plant the remainder of the crop until about the month of June, and much of that which was planted late did not germinate, and it was not until the latter part of June that it could be said that the crop was fairly up, and not until early in July was the crop reduced to a stand. Much of the land was so overrun by grass that came up before the plant that the stands were made imperfect by the choppers, and in some instances the crop was abandoned, so that about one-third of the crop was very late, and the continued rains caused that part of the crop to grow unusually fast, taking on and holding but little fruit.

The early cotton, while it grew very slow in June and the first part of July, had fruited well, when the rains, the want of sunshine, and the low temperature in July and August and the two weeks in September caused the plant not only to shed, but to rust, the seed to sprout in the open bolls, thereby destroying much cotton and badly injuring the staple, so that the prospects of a fair average cotton crop is not encouraging, and will certainly fall far below the crop of last year.

SOUTH DAKOTA AND NORTH DAKOTA.

From Mr. Samuel W. Glenn, observer, Weather Bureau, director of the South Dakota weather service:

The winter of 1890-'91 was milder than usual until after February 1. The greater portion of February was warmer than the seasonal average. Stock fed and fattened on the range most of the winter, thereby enabling stock men to carry them through on what would otherwise have been a serious shortage of feed.

A little seeding was done at favorable opportunities in the early part of March, but this work was not general until the latter part of the month, when it was prosecuted under favorable conditions of soil, due to the melting of recent snows. Interruptions were frequent during the month from frost, cold, and snow.

In the first half of the month of April seeding was interrupted by windy, cool, and rainy weather in most sections, but every favorable day was utilized. The latter part of the month warmer and more favorable weather prevailed, and by the 24th much of the grain was well sprouted and growing under most favorable conditions of both moisture and temperature, inducing a much larger acreage to late wheat than was anticipated. The month closed with the sprouted grain in South Dakota in luxuriant growth, and most of the seeding done; while in North Dakota, latitude considered, as favorable conditions prevailed, but work not so well advanced. Frosts occurred in North Dakota and portions of South Dakota the latter part of the month, but no serious damage reported.

The first week of May was unusually cool, and frosts did slight but temporary damage to staples in North Dakota and northern South Dakota, and considerable injury to berries and early vegetables. The temperature was below the average most of the month, and showers were local, some localities feeling the need of rain very much during the last week, especially for corn, and some specially late small grain that had lain in the ground unsprouted for some time. Frequent high winds added to the effect of the droughty condition. This condition was, however, permanently relieved by general showers on the 28th and 29th. Corn planting was general during the month. The month closed with North Dakota in better condition in point of moisture than South Dakota, with crop advancement correspondingly satisfactory. In South Dakota corn was doing fairly well, but needed warmer weather.

The temperature of June was below the average, as also the amount of sunshine. Unusually heavy and opportune rains occurred over both States, stimulating all crops to phenomenal growth. High winds were slightly detrimental, and local hailstorms inflicted some injury, but the general conditions were exceptionally favorable to small grain and grasses. Corn, already behind the seasonal condition, would have done better with warmer weather. In localities where the droughty conditions of May had seriously injured crops the ground was reseeded to something of later maturity. The conditions during June converted the fears of May that there would be a repetition of former unfavorable seasons into rejoicing, and the month closed full of promise for a most bountiful crop of small grain and grasses. June practically made the wonderful small-grain crop produced by the Dakotas during the season.

The temperature of July was below the average, while the rainfall was about the average over North Dakota and below over South Dakota. The amount of sunshine was about the average. The conditions highly favored small grain in South Dakota, but in North Dakota the growth was most too rank; considerable complaint was made of "lodging," and fears were entertained that grain would not mature before possible early frosts might injure it. By the 25th the harvesting of small grain was well advanced in South Dakota, and progressing under most favorable general conditions. Localities in North Dakota had reported light frosts, but no serious damage. Local hailstorms did some damage in both States. The month closed with the harvesting of small grain in southeast South Dakota practically completed and elsewhere well advanced, while in North Dakota most of the rye and barley was cut, with indications that general harvest would begin about August 10.

During August the absence of general rains, the abundant sunshine, and higher temperature all combined to produce the most favorable weather for the completion of the ripening, harvesting, a limited amount of thrashing, and late hay-making in South Dakota, and pushing toward completion of the harvest in North Dakota. Corn (not a staple in North Dakota), considerably behind the seasonal condition at the close of July, made marked advancement, and garden stuffs and grass crops developed finely. Unfortunately, a frost occurred over most of North Dakota and northern half of South Dakota on the 22-23d, doing considerable damage to small grain in North Dakota (in quality more than quantity) and killing vines and vegetables, and damaging corn considerably in South Dakota in areas, many localities in the frost belt escaping with little or no injury. Timely warnings from the Weather Bureau doubtless did much good, as "smudges" were general in both States. Some damage was done in both States by local hailstorms. The month closed with South Dakota busy successfully garnering the most bountiful and highest quality small-grain crop that she has ever produced, and North Dakota pushing to completion the harvesting of a very heavy crop, inferior only to that of South Dakota in that some of it has been damaged by frost.

The temperature of September (1 to 12) was below the seasonal average over both States. Rain is needed generally for fall plowing. Heavy frost occurred over North Dakota and the greater portion of South Dakota on the 2d and 3d, but no special damage reported from North Dakota, the bulk of the small grain being harvested; but in South Dakota, taken in connection with the effect of the August frost,

in many localities corn suffered considerably, and the frost injured vegetables farther south than in August. Corn will mature in southeast South Dakota, elsewhere the frost injury is permanent, and as a whole the corn crop can be called but "fair." The crop season is practically ended in both States, and it remains for the Dakota farmers but to convert the surplus of their overflowing granaries into other necessaries and comforts of life.

TENNESSEE.

From Mr. J. B. Marbury, observer, Weather Bureau, assistant in Tennessee weather service:

General farm work was commenced in Tennessee about the middle of March, nearly one month later than the usual time, owing to the unseasonable weather, which was cold and wet. Very little progress was made in general farm work until about the second week in April.

During the latter part of March the weather continued so cold and wet that farmers were delayed in preparing the land for planting, and what seed had been previously planted was greatly damaged. These conditions culminated in a cold wave and heavy frost about the 6th of April, which did some damage to fruit and killed a good deal of young clover.

During the third week in April the weather was about normal and generally favorable to farm work. During this period large areas of corn were planted and preparations made for the planting of cotton, which was commenced about the middle of the month. The area planted in cotton this season was somewhat smaller than usual, as many farmers have turned their attention to clover, grasses, and live stock.

The area sown in oats was also small, owing to the delay in getting the land ready for planting.

A large area of Irish potatoes was planted, and although the early part of the season was rather cold and unseasonable a splendid crop was made.

Wheat continued in good healthy condition during the entire season, except a slight damage by rust in the northern sections, and a very fine crop was harvested and saved.

Tobacco plants were rather small, but in good condition when planted during the latter portion of May and first of June. Soon after the first plantings a short drought set in and many of the plants died, but the second planting made a good stand, and an average crop is assured unless destroyed by an early frost.

A drought set in about the 3d of May and continued till the 18th. This was accompanied by unseasonably low temperature, which greatly retarded the maturing of nearly all crops.

A good deal of cotton was killed outright, and the land had to be replowed and a second planting made, and this crop will not be saved unless there should be no frost till late.

Good seasonable weather continued through the months of July and August, and crops of all kinds did well, except cotton, which was somewhat injured by the abnormally cold nights during the last week in August.

During the first two weeks in September the lack of rain caused a drying and hardening of the soil to such an extent that plowing for wheat and other fall seeds had to be suspended, and these conditions exist at the close of the week ending September 12.

The early corn crop was the largest that has been raised in this State for years, but the late crop is not at all encouraging, and unless good rains occur in a short time there will not be more than a third of the usual crop.

Cool nights and warm dry days are now rendering the cotton outlook rather gloomy.

TEXAS.

From Dr. I. M. Cline, local forecast official, Weather Bureau, Galveston:

During the month of January the precipitation was in excess over all portions of the State, the average above normal being over 3 inches. That this excess did not fall in heavy rains is shown by the fact that the number of rainy days during the month averaged about 12 per cent above the normal, and consequently the greater part of the precipitation was absorbed and retained by the soil. The temperature averaged 2 degrees above the normal, which, with the showery weather, was very favorable for the wheat crop of the northwestern part of the State. During the months of February and March the precipitation was generally deficient. During February it was less than 50 per cent of the normal, and the number of rainy days was about 20 per cent below the normal; while during March the amount was from 1 inch to 1½

inches deficient, except over north Texas, where it was above normal, but the number of rainy days was generally about normal. General farming operations began in February, when plowing for cotton, corn, and other crops was entered upon in all portions of the State. The rainfall of January, with what rain fell during February, kept the ground in unusually good condition for cultivation, while the exceptionally fair weather enabled rapid progress in farm work. During March and until the 10th of April the same favorable conditions as prevailed during February continued, and farming operations progressed rapidly. Frost from April 3 to 5 did some damage to the fruit crop. By April 10 the corn crop had been planted and was generally coming up; the greater part of cotton had been planted over the southern portions of the State and planting was under good headway over other portions. From April 10 until the 1st of May the rainfall was above the average and the temperature was about the average, which brought up corn and cotton generally, the planting of cotton having been completed in the southern and central portions of the State by April 20, and in all sections by May 1. During the latter part of April the Brazos River overflowed its banks and did some damage, which necessitated replanting a few thousand acres of cotton and corn; this, however, was replanted by May 7, and came up and grew off rapidly. The precipitation for May averaged about 2 inches below the normal, but it fell on about the average number of days and was well distributed throughout the month, except along the coast and over the eastern portions of the State, where the number of days as well as the amount was deficient. On May 17 considerable damage was done by hailstorms in the northern and eastern portions of the State, and slight damage in one or two of the western counties; about 25,000 acres in cotton, corn, wheat, and oats were badly damaged, and about 4,000 acres were entirely ruined; this was, however, all replanted in cotton. The temperature during May averaged about 2 degrees daily below the normal, and this had the effect of retarding the growth of both cotton and corn. The cotton plant on the 1st of June was small in consequence of the cool weather, but was generally healthy, and the crops were unusually clean and well cultivated and the general outlook was better than the average at this season of the year; in some sections there had been a large increase in acreage, while in a few there had been a falling off, yet the average for the State over last year showed an increase of about 7 per cent, which makes the total cotton crop of the State this season about 5,000,000 acres. There was also an increase in the acreage cultivated in corn; the growth of corn had not been materially retarded by the cool weather and the crop was very promising. The weather throughout the season had been favorable for small grain, of which there was also a much larger acreage than last season; the weather during June was favorable for harvest, and the largest yield of wheat per acre was made that has been produced for some years. The oat crop was slightly injured in some sections by the cool weather and deficiency of rain during May, but the crop was generally about the average.

During June and July the weather was showery, with about normal temperature. The rainfall was from 1 to 1½ inches deficient, but the number of rainy days was nearly normal, and as a result crops did not suffer to any great extent from the deficiency, which from May 1 to July 31 amounted to nearly 5 inches. The cultivation of corn was completed by June 30, and of cotton by July 15. With an average season after August 1 the cotton crop would have been heavy. The previous deficiency in rainfall would have been considered beneficial, as it had given good opportunity for work, and crops had never been better cultivated. At this time, however, the cotton plant was putting forth blooms and bolls at a rapid rate, and it required at least an average amount of rainfall, particularly on account of the previous deficiency, but a large deficiency continued during August, and by the middle of August prospects had fallen off materially on account of drought. Worms, which had appeared in a few sections about the 1st of August, spread rapidly between August 10 and 20 and threatened a great deal of damage. However, unusually cold weather for August occurred from the 23d to the 25th, which checked the spread of worms, and this was followed by another cool spell between the 1st and 10th of September, which stopped them entirely, before material damage had been done. The temperatures throughout the State, while decidedly below the average, were in no instance low enough to injure the cotton plant. Some claimed that the cool weather had caused rust, but on close examination what appeared to be rust was found to be leaves turning yellow from dry weather.

The deficiency in precipitation did not injure the corn crop except in some parts of southwest Texas, where the drought was most severe; taking the State as a whole, the corn crop was slightly above the average. The good yield of corn can be accounted for from the reason that the crop was made before the middle of July and that the season in the ground at the time of planting was sufficient, with the current rainfall, to keep all crops in a flattering condition until toward the last of July. During the latter part of August and the first of September drought continued generally throughout the State and cotton suffered severely, and the prospects for

cotton continued to become more unfavorable, and by the 1st of September the plant had stopped growing over southwest Texas and in a few localities over eastern Texas, yet in other portions the top crop continued to stand the drought very well, and it is believed that the showers since the first of the month, with favorable weather from this time on, will make an average top crop over at least two-thirds of the State. The bottom crop was excellent throughout the State, and the middle crop will make a fair yield. Cotton-picking is much further advanced than at a corresponding time in any previous season, and the staple is longer and much cleaner than is generally the case.

Some have estimated that the effects of the drought since August 1 would result in a decrease ranging from 20 to 25 per cent per acre from last year's yield. This, however appears to be greater than would result with the loss of the entire top crop; since in 1882, the best yield ever produced in the State, the top crop was placed at less than 15 per cent of the entire crop. Up to the 1st of August the crop looked as well over the greater part of the State as it did in 1882, and the top crop now gives promise of a fair yield in the greater part of the State; consequently, if the cotton is picked as clean as it was last season, and with favorable weather from this time on, the yield per acre will hardly fall more than 12 per cent below that of last year, which would give a yield of about thirty-eight hundredths of a bale per acre; and this, with the increased acreage, would give an aggregate yield of about 1,800,000 bales for the State.

VIRGINIA.

From Mr. J. N. Ryker, observer, Weather Bureau, assistant director of the Virginia weather service, Lynchburg:

The date of beginning of general farming operations in this State in 1891 was very much delayed by reason of continued and excessive rains in February and March, with temperature generally below the normal until about the 4th of April, so that little preparation for spring crops could be made before the latter date. This was followed by eighteen to twenty days of favorable weather, excepting frosts on April 7, 8, and 9, that slightly damaged fruit which was then in bloom; all kinds of fruit were in bloom between April 10 and 20. Some corn was planted and oats seeded during last ten days of April, though the last week of the month was too dry for plowing. Tobacco beds were not made this year until in April in most sections. Serious drought continued from April 25 to May 16 in all portions of the State, and, in the north and northeast portions until about May 25 to 30, stopping corn planting and plowing, causing almost an entire failure of the first crop of clover and damaging the oat crop more than 50 per cent, and killing the greater part of the new grass crop. After June 1 the conditions proved generally very favorable to all crops, especially to tobacco, and everything improved; these conditions continued until about July 25, followed by continued rains and too much cloudiness, with excessive rains in south and southeast sections, that damaged the melon, tobacco, peanut, and potato crops, with cool weather the last week of August and first week of September, that retarded corn and tobacco. Since September 11 the conditions have been very favorable; fall plowing is probably nearly all finished, under favorable conditions, and prospects are bright for fall seeding.

The following data will prove to be a tolerably correct statement for the crops of the State:

Oats: Usual time of seeding, about March 1; this year, from April 1 to 25, and the amount cut off by dry April and early May.

Tobacco plant beds: Usually from in winter up to March 1; this year, nearly all after April 1.

Corn planting: Usually about April 15; this year some from April 20 to May 1, but mostly from May 20 to June 20.

Clover crop harvesting: Usually about June 1; this year very little of first crop harvested, and second crop cut from June 20 to July 20.

Tobacco plant setting: This year, about the usual time, May 20 to June 20 or 25.

Wheat harvest: Usually about June 20 to July 10, and this year about the same time.

Oat harvest: Usually about July 10 to July 25; this year, July 15 to August 1, with very short crop.

Hay harvest: This year, about the usual time, from July 20 to August 20, with a fairly good crop.

Corn fodder pulling: Usually begins about August 20; this year, September 1.

Corn-cutting: Usually about September 1, but this year will be near October 1.

Tobacco cutting: Usually August 20 to October 1; this year, September 7 to October 15, if frost should not occur sooner.

The fruit crop has proved an abundant one.

Oats was about one-third to one-half an average crop.
Wheat probably about three-fourths crop.
Hay crop about an average.
Pastures have been good since June 1, and are in excellent condition.
Corn promises a large and good crop.
Tobacco, a fair to large crop, though the quality has been injured by rains and cloudy weather and the cool weather from August 25 to September 9.

WISCONSIN.

From Willis L. Moore, local forecast official, Weather Bureau, director of the Wisconsin weather service:

April 1 found about 2 feet of snow on the ground in the northeast part of the State, 2 to 6 inches in central and northwest portions of the State, and the southern part uncovered. Plowing and seeding began in southern part about April 15. At this time it was considered that winter grains had come through in excellent condition, and that winter wheat especially was in fine shape; but the season was thought to be about two weeks late. The last half of April was warm enough to advance the season fully up to the average. Spring plowing and seeding completed in the southern counties the last week in April, and also finished in the northern section by May 10.

The Crop Bulletin of May 2 said, in reference to the high temperature of the two previous weeks: "The weather has been too warm for the cranberry vines, starting them too early and thereby making them liable to be frosted later on." This premonition was fully justified, for before the expiration of another week severe frost occurred in all parts of the State, with minimum temperatures ranging from 19° to 35°, and the prematurely developed cranberry shoots were considerably touched. However, the effects of this cold were greatly mitigated by the fact that little or no rain had fallen for eighteen days previous and all vegetation was comparitively dry. Winter wheat, pastures, and spring-sown grain were but little injured.

This drought condition continued up to about May 20, the ground being so dry as to cause farmers to hold off in planting corn. Corn, therefore, entered the ground late and under very unfavorable circumstances. An average of about 1 inch of rain now fell over the State, but its good effect was transitory and the drought remained unbroken. Severe frosts occurred on the 25th and 26th, ice forming one-fourth to one-half an inch in thickness in the interior counties. Again the dry and backward condition of vegetation made the effects of the frosts but slightly apparent.

The rosy prospects of April slowly but surely deteriorated as the season advanced without material rainfall, until on the 1st of June the parched ground and the withered leaf of vegetation promised anything but a bountiful yield for the crops. Corn and hay were particularly unpromising, and many fields of wheat were nearly as bare as when sown, four to six weeks before. But the temperature during May was 4° below the normal, which tended greatly to preserve the vitality of plant life during the drought period. Had abnormally high temperature been coincident with the May drought its severity would have been greatly increased and the power of the growing crop to recuperate with the coming rains of June been considerably lessened.

But what a change occurred during the month of June. While the rainfall was below the normal in the northern portion, it was heavy enough to break the drought, and in the southern and west-central part it was from 1 to 3 inches in excess. The temperature during the month was also all that could be desired, averaging 1° above the normal. It may be said that the wheat, rye, and potato crops were made by the rainfall and temperature of the month of June. Everything seemed to take a new lease of life; fields that were considered hopeless came forward with such astonishing rapidity that at the end of the month all crops promised well except hay. While more rain of a slow, soaking nature would have been beneficial, still there was enough moisture stored in the ground during the month to carry wheat, potatoes, and oats through the extremely dry months of July and August to a successful maturity and a good yield. But not so with the hay crop. The question at once presents itself: If the rainfall were sufficient to produce a fair crop of cereals, why should not the meadows produce their proportionate quota of hay? The answer is probably found in the fact that the grass stocks grow much closer than those of the cereals and that the roots are matted and many-fold more numerous, and therefore consume a greater amount of moisture. To be sure, the sod protects the undersoil and retards evaporation, but this probably does not compensate for the great draft made upon the moisture of the soil by the numerous roots. The crop was about one-half the average, and was entirely harvested during July.

July was cool and dry, the rainfall being 1 to 3 inches below the normal and the temperature 5° to 10° below, conditions very unfavorable to corn.

August opened with the hay crop all in, barley and spring wheat being harvested in eastern counties, corn small and unpromising from the effects of the continued cold dry conditions; tobacco looking well, and cranberries promising fairly well. It will be remembered that the tobacco district of the State was thoroughly saturated during the June rainfall. Bountiful rain fell in the northeast portion of the State during the first week, and relieved all anxiety in regard to the principal crops this season in that district, so far as rain was concerned. In the remaining part of the State the drought affected pasturage to such an extent that in many counties farmers were feeding nearly as much hay as they do in winter. By the middle of August the early-planted tobacco and all grains were being harvested, with a good yield. On August 20 a very beneficial rain fell over the whole State, but not enough to permanently relieve the drought. The low-pressure area that caused this rain was followed by a high-pressure area and a cold wave, which caused killing frost in the cranberry region and light frost on the northwest border of the tobacco belt. Warnings were telegraphed twenty-four to forty-eight hours in advance of the frost, but owing to the drought condition which had prevailed during most of the season many marshes could not get water, and two-thirds of the crop was totally destroyed. Corn and buckwheat in the north-central and northwest counties were also severely damaged. Tobacco was unhurt, and the rain of the 20th was just what was needed to save the late fields from the drought, which now began to seriously threaten them.

The cool wave and frosts of the last week of August were followed by another cool wave and much heavier frosts on September 4, which froze and destroyed many fields of buckwheat and corn in the central and northwest counties and caused frost over nearly the entire tobacco belt. No serious damage was done, however, to tobacco. Warnings were sent forty-eight hours in advance of the frost. The abnormally low temperature and deficiency of rainfall during July and August—the principal time for making the corn crop—combined with the severe blight by frost in the northwest half of the State, tells the story of the short corn crop. During the severe frosts of the latter part of August and the first of September the protecting influence of the lake in keeping up the night temperature was such that no frost occurred in the coast counties.

Altogether the year was a fairly successful one for the farmers of Wisconsin. Wheat, rye, oats, potatoes, tobacco, and barley, good crops; with corn, hay, and cranberries very light. It is, indeed, surprising that such bountiful products could come from the soil with so little rain. In this connection it should not be forgotten that, with one exception, the periods of least rainfall were accompanied by moderately low temperature. This gave but little evaporating power and left to vegetation the full measure of all moisture in the soil.

THE INTERNATIONAL CONFERENCE.

By Prof. CLEVELAND ABBE.

The International Conference of Meteorologists held in Munich in August, 1891, was an occasion of much importance both for meteorology and for agriculture as one of its practical applications. As the Chief of the Weather Bureau and myself had been commissioned to represent the Department of Agriculture on this occasion, it was deemed by us especially important to give as much attention as possible to the bearing which the discussions should have upon agricultural matters. The fact that at this conference representatives of this Bureau were present occasioned many congratulatory expressions, and has, we believe, served to arouse a lively interest in the work that is being undertaken in this country. The selection of the Chief of the Weather Bureau as one of the two vice-presidents of the conference, and also as a member of the permanent international committee, will demonstrate to you the appreciation in which our weather service is held by foreign meteorologists.

As the resolutions adopted by the agricultural conference held at Vienna in 1880, as well as those of the Rome congress in 1879, are intimately connected with those adopted at the present Munich congress of 1891, they should all be carefully considered in laying out the work of our agricultural stations and our State weather services, and it

is hoped that they may be printed elsewhere in full. These numerous resolutions are the official expression of the best conclusions that could be agreed upon by large bodies of men who have the widest knowledge upon these subjects. To those who, by local experience, have arrived at the positive conclusion that a special style of instrument or method of using it is the best, or that a special climatic influence is the most important, some of these resolutions may appear, at first thought, wanting in precision and force, but the fact is that owing to the extreme complexity of the subject of meteorology and climatology and the conservatism of human nature, these generalized resolutions express all that it has been practicable to agree upon as fundamentally important and practically attainable. From this point of view we must hail many of these resolutions as indorsing the present practice and policy of the Weather Bureau, so that, as it would seem, our methods are not only free from the criticism of being different from those of other countries, but are in many respects recognized as a step in advance, and therefore praiseworthy.

Among the resolutions adopted at these various conferences it is proper to dwell upon a few that are of general interest to this Bureau. That which affects us most directly is the assignment, at the request of the Chief of this Bureau, to the international committee of the duty of drawing up a special report on the relations of meteorology to agriculture. It will possibly be several years before such a report can be completed, and meanwhile my report already on hand on this subject may serve as an earnest of what is to be hoped for from the committee. The dependence of crops and all agricultural operations upon the climate and the weather occupied much attention during our rapid run through Europe. We found the north of Europe still suffering from cloudy, cold, wet weather up to the 1st of September, and although during the first half of that month we enjoyed dry clear weather in southern Germany, Austria, France, and England, yet the crops were backward and deficient.

Agricultural interests seem to be especially studied by the weather bureaus of France, Austria-Hungary, Bavaria, and Saxony; in the last two the study of local thunderstorms and hail during the growing and the harvest seasons has made such progress that it would seem to be possible to predict the general path of a storm during its growth and its dissolution when once its existence has been recognized in the morning. Doubtless a similar result can be attained in the United States, or in any portion thereof, whenever a system of thunderstorm observers, at an average distance of 5 miles apart, can be secured. The efforts made in this direction in former years, by the coöperation of Gen. Hazen and the Post-Office Department, deserve to be renewed. As an illustration of what may be done in this respect, it is proposed that this Bureau surround the city of Chicago as soon as practicable, and possibly other cities, such as New York and Washington, if practicable, with such a minute system of reports that the arrival of every thunderstorm, with its short squall of wind and rain, shall be regularly predicted. The successful working of such a system during the Columbian Exposition will undoubtedly lead Chicago and other cities to make similar and permanent arrangements at their own expense, for it is hardly probable that such expenses for all the principal cities of the country can be borne by this office.

Among the European meteorologists who have shown great sympathy with the needs of the farmer is Dr. Paul Schreiber, director of the Meteorological Institute at Chemnitz, Saxony, and from his recent

address to the farmers' convention the following, which is equally applicable to our own country, is quoted:

The price of subscription to the daily weather map is only $2 annually, and it is remarkable that this important aid in judging the future weather is so little used by the farmers. That which is most necessary in order to give the predictions their full value is the more rapid distribution of the weather map, so that at 6 p. m. every farmer would receive notice of the weather to be expected the next day. Perfectly accurate predictions are not to be expected, but very useful indications of the probable character of the weather can be derived by the farmer from the weather map, and especially as to whether it is likely to rain or not, and 75 per cent of the predictions of rain in Saxony are found to be completely verified and only 9 per cent entirely fail. Perhaps many of you think that you can do as well by glancing at the sky and at the "weather glass;" but, however this may be, you will often have experienced how easily you are deceived. You would have made a very different prediction if you could have gone up high in a balloon and have taken a general view of the atmospheric conditions all over Europe.

This bird's-eye view is accomplished by means of our weather charts which show us whether causes are approaching us far beyond the narrow limits of our horizon that can bring about a change in the weather. The weather chart shows that no matter how pleasant the weather is in our own locality, an area of rain is approaching; on the other hand, when it is raining in our locality, whether it will soon pass by or continue for a long time. It oftens happens that a long period of fine weather or of rainy weather is interrupted by one or two rainy or clear days, respectively. I believe that for outdoor work it is principally important to know whether there will be a series of rainy days or dry days. One rainy day in the midst of many dry ones can scarcely be of much influence in farming operations. Here we see the inestimable value of weather reports, and especially of weather charts; they show why it is raining or dry, and why it is warm or cold; whether the existing weather will last a long time, or is only temporary. We often see in the charts the evidence of a coming change in the weather a long time before there is the slightest sign in our sky or our instruments.

But we can attain skill in anticipating the weather only by a thorough, earnest, and pertinacious study of the weather reports. I can not too earnestly recommend to every one to begin at once to study the weather charts, and not to relinquish it even although they do arrive late every day and though there may be some difficulty at first in understanding them. They will at least arrive early enough to enable you to understand the weather of the day that is past, and from *that* you will be enabled to conclude, from the present aspect of the sky and readings of your local instruments, what the next change will be.

A more intimate connection between the meteorological office and the farming population will be a benefit and a blessing to both.

The short time at our disposal allowed us to visit only one agricultural experiment station—namely, the celebrated establishment of Sir John Lawes, Rothamsted, Herpendon, Hertshire. It is a pleasure to be able to record that by a special clause in his will Sir John has provided for the maintenance of this important work during all future time. Of course, the results attained in the climate of Rothamsted can not be directly applied to the climate of any part of the United States, and indeed the same may be said of results obtained in the special climate of any other locality.

This suggests mention of the fact that the study of climate has been carried by European meteorologists to a degree of refinement that is not yet attained in America. We are apt to speak of the climate of a State, whereas we should speak of the climates within a State, or the climate of a special farm, or even of a small field, because each individual plant prospers or languishes according as the temperature and moisture of its own locality is favorable or not. Thus an eminent German climatologist criticised in our hearing the location of some instruments amid trees on a slight rise of ground and possibly a hundred feet above the surrounding plain, objecting that these instruments could not properly represent the climate of the surrounding country, but that they should have been placed in the open flat fields near at hand. If this person be correct, it is evident that the demands of agricultural cli-

matology are very different from those of dynamic meteorology, or the study and prediction of daily weather. This latter has been the object of the Weather Bureau in its past history, and has led to the establishment of its instruments as high as possible above the ground, and generally within larger cities. These stations, established in the interest of meteorology proper, have given the service its present high standing, and of course can not be relinquished. On the other hand, climatological studies must be made near the earth's surface and in the open country, as is done at most of our voluntary stations, and it will be an important result of our inspection of European institutions if we shall have received a decided stimulus in the direction of minute climatology.

It was a very pleasant surprise to European meteorologists to learn that we had so large a number of stations of the first order, at which, namely, continuous records are kept. The general resolution of the conference would require that these observations, as well as those at all our other stations, should be published in accordance with a system that has been drawn up for the guidance of European governments. Although this publication will consume much labor and involve much expense for printing, yet it will be eventually a decided saving, as these climatic records are in continual demand and must be distributed to those who study climatology in its relation to agriculture and manufactures, and especially to all State agricultural colleges and experiment stations. The so-called "international form" of publication should begin with the present lustrum, 1891-'96; it is adapted to pages of the quarto size, and is undoubtedly as economical as in any way consistent with the proper presentation of the data.

The Chief of this Bureau was pleased to be able to represent to the congress the fact that the exposure of a rain-gauge on the roof of a large building, as is generally necessary in our city stations, is not necessarily very objectionable, provided the gauge be placed near the center of a large flat roof, and the resolution passed by the congress on this matter has finally removed a criticism that has often been made upon the American observers. It is very desirable that in this place, and by the wide distribution given to the Annual Report of the Department, the attention of every citizen be called to the fact that there is still a lamentable need of more records of rainfall. The Bureau is prepared to coöperate heartily with everyone, whether in the city or in the country, who will keep a proper record of the time and amount of rainfall at one or more localities.

At the present time meteorological observations are probably weakest in that which would seem to be one of the simplest matters of observation, namely, the study of the clouds. On this point the conference has expressed an especial desire that every country should awaken to the importance of this subject. Through its special committee it proposes to superintend the publication of an atlas showing the forms and varieties of clouds, with appropriate nomenclature; and, on the other hand, it hopes to secure a large number of stations at which the heights and actual movements of the clouds will be carefully observed. This latter work, owing to the skill required, must almost necessarily be largely left in the hands of special meteorological observatories and the professors of meteorology at our universities, agricultural colleges, and experiment stations, who can do much for meteorology by entering upon this class of work. The various methods of measuring altitudes will be communicated to anyone who makes inquiry of this office.

The resolutions of the conference calling upon all nations to compare

their instruments with each other, and with those of the international bureau of weights and measures; the resolution to adopt the air-thermometer in all temperature work, and to compare all thermometers at very low temperatures; to adopt the reduction of the barometer to standard gravity; to adopt a steady ventilation in the use of the psychrometer, and to introduce everywhere the registration of sunshine, are, it is gratifying to state, all more or less completely carried out by this Bureau.

The international bibliography of meteorology, as begun by Gen. Hazen and published in part by Gen. Greely, seems to have attracted the greatest interest among European students, as it attempts to satisfy a want that has long been recognized. We were so fortunate as to enjoy a prolonged interview with Dr. Hellmann, at Berlin, and Mr. Symons, in London, but missed seeing Mr. Lancaster in Brussels, the three Europeans who have probably done the most work in connection with the bibliography of meteorology. Evidently the general sentiment in Europe is to the effect that the great work thus far done by the Signal Office is too important to be left unfinished, and that the interests of meteorology and of climatology alike demand that the Weather Bureau shall publish the complete work in proper style, after obtaining from European colaborers all possible corrections to the manuscript that has already been milleographed.

The resolution of the conference urging the desirability of publishing as velocities of the wind only the corrected readings of the anemometers will, if carried out, involve this service in considerable extra work, and its execution may not prove to be practicable; yet the propriety and desirability of this improvement is generally acknowledged, as it seems likely that all velocities as measured by the ordinary Robinson anemometer are from 15 to 25 per cent too large. On the other hand, the office will be glad to increase the accuracy of its results if possible by the introduction of any better form of anemometer, if such can be devised.

The conference decided, as on previous occasions, that the introduction of zonal time, or any departure from the customary local mean time in meteorological matters, would be very regrettable; but as the system of standard times adopted in this country can not be changed, and is in fact very beneficial to the work of this office, there seems to be no reason to change our customs in this respect. Considered as a great popular convenience, there is no doubt that the zonal system makes friends wherever it is introduced, and strong demonstrations have been made on many occasions in Europe in favor of its introduction there. The original records of this service are kept on the seventy-fifth meridian time, which is the standard in Washington, and its uniform adoption simplifies our work. Experience has shown that since the adoption of uniform standard time the innumerable errors of five, ten, or even twenty minutes in the watches and clocks of voluntary observers have been avoided, and it is only by the help of this great accuracy that we shall be able properly to study thunderstorms, auroras, meteors, earthquakes, and other interesting phenomena.

Many of the members of the conference expressed to us, as has so often been done before, the great value attached by European students to observations on high mountain stations, and regretted exceedingly that the stations at Pikes Peak and Mount Washington should have been given up without securing from each a complete determination of the diurnal variations of the meteorological elements. Our station on Pikes Peak and the one temporarily occupied on Mount Whitney have

always enjoyed the reputation of being by far the highest of any in the world, and if the expense is not too great and local sentiment supports the movement, we surely may hope to reëstablish these and many other mountain stations, furnishing them with self-recording instruments and publishing the results, thus materially contributing to the progress of meteorology.

The committee of the conference to which the question of terrestrial magnetism was referred, besides going into certain details as to instruments and methods, expressed the general desire that the subject of terrestrial magnetism should be provided for by the national weather bureaus when practicable and when not otherwise specifically provided for in each country. It would seem that this important subject may be considered from the view of the needs of the navigator, of the surveyor, and of the meteorologist, and as the relations between magnetism and meteorology have lately assumed a very interesting shape, considerable attention should, with your permission, be devoted to this subject.

After the close of the conference at Munich there was held a conference of delegates from the Governments interested in the international polar work of 1882–'83, at which your representative was present as a guest, and received the request to coöperate as far as possible in encouraging and developing the magnetic investigations of our fellow-countryman, F. H. Bigelow, since appointed by you as professor of meteorology in the Weather Bureau, with a view to the further development of the relation between these two subjects.

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